economics

CIMMYT Economics Working Paper 88/02

Comparative Advantage and Policy Incentives for Wheat Production in Zimbabwe

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Acknowledgements

Many people helped in the preparation of this paper, and it is impossible adequately to pay tribute to all of them. However, several individuals deserve particular mention. Mandi Rukuni and Carl Eicher, Co-Directors of the UZ/MSU Food Security Project, identified the need for analysis of wheat policy options in Zimbabwe and invited CIMMYT to participate in the Food Security Project research program. Jim Longmire of CIMMYT, Peter Ngobese of ARDA, and Solomon Tembo of the University of Zimbabwe conducted the preliminary survey of commercial wheat farmers and were instrumental in helping to frame the research questions addressed by the present DRC study. Data used in the budget analysis were provided by, among others: Aidan O'Driscoll of MLARR; Philip Fulks and Peter Wells of CFU; Pascal Mpunzwana of AMA; Coos de Jong of AGRITEX; Richard Stenson of ZTA; Godfrey Mudimu, Kay Muir, and Jayne Stanning of the University of Zimbabwe; Martin Mucheru of Newman International; and Rob Smith of P.T.A. Consulting Services. Jim Longmire and Larry Harrington of CIMMYT, and Scott Pearson of the Food Research Institute, read a late draft of the paper and provided many thoughtful and constructive comments. Thembi Sibanda of the University of Zimbabwe and Dolly Harris of the CIMMYT Regional Office in Harare handled administrative details in Zimbabwe, while Kelly Cassaday, Ana Gloria Nunez, Miguel Mellado, Maria Luisa Rodriguez and Margarita Avila of CIMMYT, Mexico, assisted with the production of the final version of the paper.

Acronyms

AFC	Agricultural Finance Corporation
AGRITEX	Agricultural, Technical, and Extension Services
AMA	Agricultural Marketing Authority
CIMMYT	International Maize and Wheat Improvement Center
CFU	Commercial Farmers Union
CMA	Cotton Marketing Authority
CSO	Central Statistical Office
DRC	Domestic resource cost
FAO	Food and Agriculture Organization of the United Nations
GMB	Grain Marketing Board
IFS	International Financial Statistics
MFEPD	Ministry of Finance, Economic Planning, and Development
MLARR	Ministry of Lands, Agriculture, and Rural Resettlement
MSU	Michigan State University
NFIF	National Farm Irrigation Fund
RCR	Resource cost ratio
RSS	Research and Specialist Services
SADCC	Southern Africa Development Coordinating Committee
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
UZ	University of Zimbabwe
WWS	World Wheat Statistics
ZESA	Zimbabwe Electricity Supply Authority
ZTA	Zimbabwe Tobacco Association

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Introduction

Zimbabwe is unusual among SADCC countries in producing most of its own wheat. Between 1965 and 1975, rapid growth in wheat production transformed the nation from a net wheat importer to a net exporter. Although wheat consumption has since overtaken production and revived the need for imports, domestically produced wheat continues to make up the major part of supply.

Recent developments suggest that Zimbabwe's current high level of wheat self-sufficiency may be threatened. Demographic and economic factors have increased the demand for bread and other wheat-based products more rapidly than domestic wheat production has been able to expand, forcing the government to rely on imports to make up the shortfall. Commercial imports averaged around 100,000 t in each of the last three years and would have been even greater had the government not imposed limits. Wheat is currently being rationed to millers, who claim that demand exceeds the available supply by at least 25-30%. While such figures are difficult to substantiate in the absence of reliable consumption data, the millers' claims are supported by the frequent appearance in Harare of bread lines.

The widening gap between wheat supply and demand raises important policy questions. Some analysts have argued that wheat production could be increased considerably if official producer prices were raised to provide adequate incentives for farmers (Headicar 1987). Others have replied that wheat production is inherently unprofitable in Zimbabwe and that the country would be better off concentrating on traditional export crops such as tobacco and cotton to generate the foreign exchange with which to purchase wheat in global markets (Muir-Leresche 1987). The policy debate is complicated by the fact that most wheat is grown by large-scale commercial farmers; consequently, government policies affecting wheat are likely to have different impacts on commercial and communal producer groups.

In an era of stagnating exports, spiralling food imports, and growing uncertainty about the future political climate in southern Africa, two central questions underlie wheat policy in Zimbabwe:

1) Is it an efficient use of resources for Zimbabwe to produce wheat, today and in the foreseeable future?

2) If it is now (or might soon become) efficient to produce wheat, what combination of policy incentives and technological change are needed to promote domestic wheat production?

The objective of this paper is to provide answers to these two questions. The framework of analysis involves the calculation of resource cost ratios to determine comparative advantage in the Middleveld and Highveld regions of Zimbabwe among six major crops--wheat, maize, soybeans, cotton, groundnuts, and tobacco. Crop budgets are used to assess private and social profitability of each of the six crops under current and potential future production scenarios. Social profitability can differ substantially from private profitability because of government policy interventions and market failures. Comparative advantage is determined by calculating the economic returns to domestic resources used in the production of each crop. The results of the budget analysis reveal the effects of current policies on resource allocation in commercial agriculture and provide a basis for judging whether agricultural policies have created producer incentives that are consistent with the national interest, in the sense of maximizing efficiency.

The framework of analysis used in this paper should be of interest to analysts and policymakers not only in Zimbabwe, but also in other countries where difficult questions are being raised about how best to meet the rising demand for bread and other wheat-based products. The domestic resource cost (DRC) approach provides an operational method for measuring comparative advantage across crops and makes possible quantification of the cost of domestic wheat production vs. the cost of importing. Comparative advantage analysis thus has the potential to contribute to the food security dialogue in all countries.

A Framework for Measuring Comparative Advantage

Comparative advantage is an expression of the efficiency of using local resources to produce a particular product when measured against the possibilities of trade. In a very simple example of comparative advantage, 1 ha of land and a given amount of other inputs can be used to produce either cotton or wheat. If the yield of cotton is 1 t/ha, then at current international prices (adjusted for transportation costs) this cotton, if exported, will purchase about 10 t of wheat. Since the same 1 ha of land and the same given amount of other inputs will produce only 5 t of wheat, the country is better off meeting its wheat requirements by producing cotton for export and importing wheat. In this example, the country is said to have a comparative advantage in cotton production.

Comparative advantage can be expressed quantitatively in several different ways. One of the most useful is by means of the *resource cost ratio*, which is a measure of the domestic resource cost to a country of producing a particular commodity. Because several excellent sources are available describing the rationale for and use of domestic resource cost analysis, no attempt is made here to describe the methodology in detail (see Pearson and Monke, 1987; Byerlee and Longmire 1986; Pearson, Stryker, Humphreys, et al. 1981).

The resource cost ratio (RCR) for a particular commodity or product is calculated by dividing production inputs and outputs into *tradables*[1] and *primary factors*[2] and expressing the economic value of primary factors used in production as a proportion of the value added to tradables:

$$RCR_c = \frac{\sum_{i=1}^{m} W_i F_i}{\sum_{j=1}^{n} P_j T_j - \sum_{k=1}^{s} P_k T_k}$$

where:

RCR_c		=	resource cost ratio for crop c
W_i	(i=1..m)	=	opportunity cost prices of primary factors
F_i	(i=1..m)	=	primary factors of production
P_j	(j=1..n)	=	world price equivalents of tradable outputs
T_j	(j=1..n)	=	tradable production outputs
P_k	(k=1..s)	=	world price equivalents of tradable inputs
T_k	(k=1..s)	=	tradable production inputs

An RCR below one indicates that the value of the domestic resources used in production is less than the value of the foreign exchange earned or saved. Thus, a country has a comparative advantage in products associated with an RCR of less than one, since the country earns or saves foreign exchange in

1 Tradables are goods (or components of goods) that can be traded, i.e., imported or exported. However, not all tradable goods are actually traded, for example if trade is uneconomic or restricted by policy.

2 Primary factors are goods (or components of goods) that cannot be traded. The most important primary factors are land, labor, water, and capital.

their production. Conversely, an RCR above one indicates that the value of domestic resources used in production is greater than the value of the foreign exchange earned or saved, and the country does not have a comparative advantage in production.

One critical aspect of the calculation of RCRs is the valuation of inputs and outputs. Market prices of inputs and outputs do not necessarily reflect true economic values, because of government policies (subsidies, taxes, price restrictions, wage policies, exchange rate controls) or because of market failures. Consequently, before RCRs are calculated, it may be necessary to adjust market prices to eliminate the effects of policy-induced distortions or market failures. This adjustment is accomplished by assigning all inputs and outputs shadow prices (here referred to as "*social prices*") reflecting their true value in the economy. Social prices are determined differently for tradables and primary factors. Tradables are valued at their world price equivalent, or the price at which they can be imported or exported, adjusted for transport costs and exchange rate anomalies. Primary factors are valued at their returns in the most profitable alternative use, again expressed in world price equivalents. (For more information on pricing tradables and primary factors, see Pearson and Monke 1987, and Gittinger 1982.)

The social price of a tradable differs depending on whether it is imported or exported. If it is imported (as in the case of wheat in Zimbabwe), transportation and handling costs must be added to the world reference price to arrive at a social price equivalent to the *import parity price*. But if it is exported (as in the case of cotton and tobacco in Zimbabwe), transportation and handling costs must be subtracted from the world reference price to arrive at a social price equivalent to the *export parity price*.

A problem may arise in establishing social prices for non-traded tradables--goods and services which in principle are tradable but which for economic reasons are not traded. Typically this difficulty occurs when transportation and handling charges involved in getting a product to and from world markets introduce a wide gap between the FOB price at which the product can be exported and the CIF price at which it can be imported. Whenever the domestic market price lies between the FOB and CIF prices, both importing and exporting will be uneconomical. For the country depicted in Figure 1, p. 5, domestic supply of Commodity X equals domestic demand at $P_{market\ clearing}$ and $Q_{s,d}$. But because of the high transport and handling costs involved in gaining access to world markets (represented in Figure 1 by the vertical distance *a-b* for imports and the vertical distance *b-c* for exports), trade in Commodity X will be uneconomical for this country even if an international market exists.

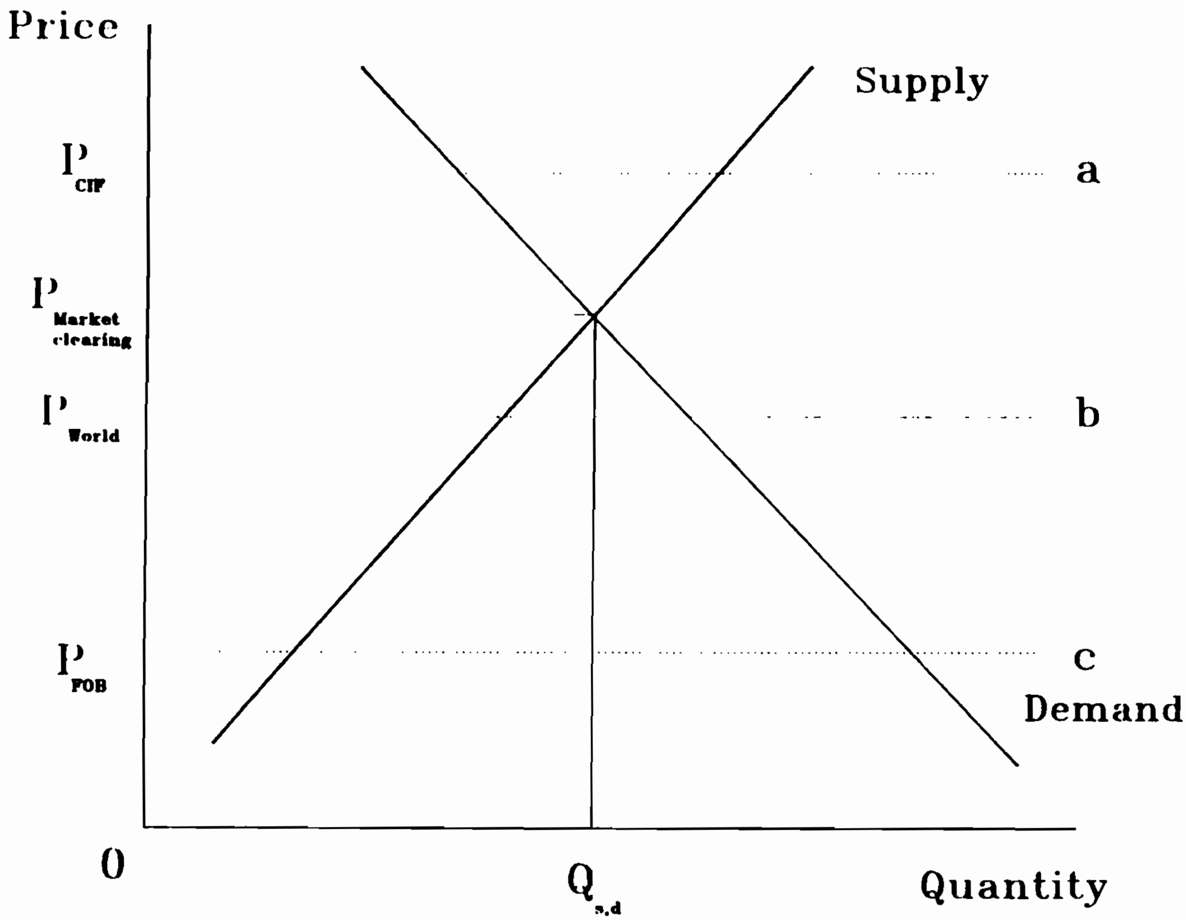

Figure 1. Conditions giving rise to a non-traded tradable.

How should social prices be determined for non-traded tradables? If the market price is an undistorted market-clearing price which effectively equilibrates domestic supply and demand, the market price accurately reflects the product's economic value and can be used as the social price. However, if the market price reflects distortions due to policy effects or market failure, an adjustment should be made to arrive at the social price. For example, in Figure 2 (p. 6), government policies have introduced a gap between the market price (P *controlled*) and the theoretical market-clearing price (P *market clearing*), equal to the vertical distance *a-b*. (In this example, the controlled market price is lower than the theoretical market-clearing price, but it could just as easily be higher.) The difference between the two prices thus represents a policy-induced distortion which should be eliminated for the DRC analysis. Whenever there is reason to suspect such a distortion, the appropriate correction is to estimate a social price equal to the theoretical market-clearing price (P *market clearing*).

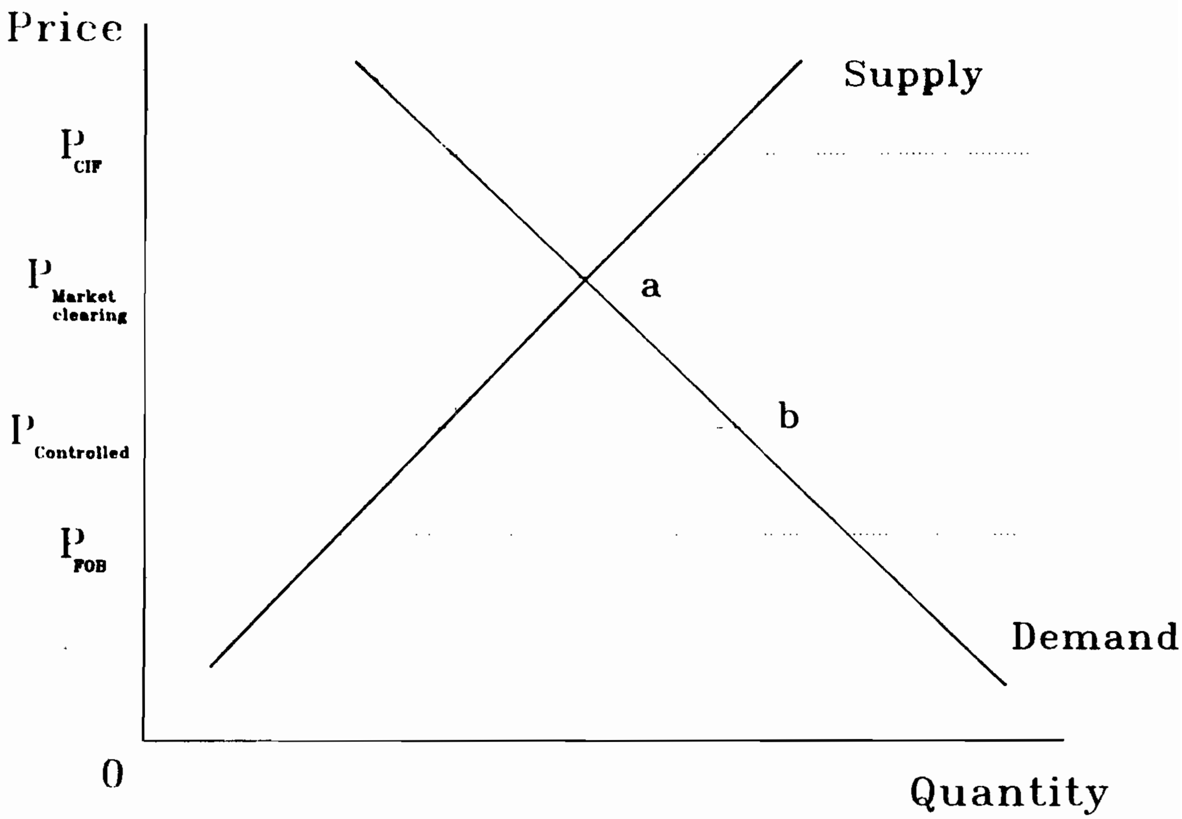

Figure 2. Establishing social prices for non-traded tradables.

In Zimbabwe, a number of tradable inputs (lime and gypsum, packing materials, electricity) and tradable outputs (soybeans, groundnuts) are not traded internationally. In the absence of clear evidence of price distortions because of policy effects or market failures, the present study uses market prices to approximate social prices for these non-traded tradables.

Social prices can differ substantially from market prices, as when farmers pay less than the full import cost of fertilizer because of a government subsidy, or when they receive less than the full value of their output because the official producer price is set below the world price equivalent. When significant discrepancies exist between market and social prices, the interests of farmers and of the nation can diverge. A crop can be profitable to farmers (e.g., because of high producer prices or subsidies on inputs), even though its production does not represent an efficient use of resources from the point of view of the nation. Conversely, a crop can be unprofitable to farmers (e.g., because of low producer prices or taxes on inputs), even though its production represents an efficient use of the nation's resources. Comparing private profitability with social profitability thus provides important insights into the impacts of government policies on producer incentives.

Wheat in the Zimbabwean Economy

Recent Macroeconomic Developments

When Zimbabwe achieved independence in April 1980, the new nation had a diversified economy by African standards, with well-developed physical and administrative infrastructure. The diversification of the economy ironically was attributable in large part to the civil war, since the relative economic isolation imposed during the period of sanctions necessitated the production of a wide range of agricultural and manufactured products for the domestic market. At the same time, even with the sanctions, the nation was able to continue to export agricultural and mining products.

Despite the relative soundness of the Zimbabwean economy at Independence, the new government faced a number of difficult challenges. Leading priorities in the development agenda included the rehabilitation of severely depleted capital stock; the restructuring of a strongly dualized economy; and the redressing of glaring inequalities between racial groups in income, ownership of land and capital, and access to basic social services such as health care and education.

The Growth with Equity program introduced at Independence achieved important early successes in helping the nation to recover from the war while moving toward a multiracial society. During 1980 and 1981, the economy experienced a rapid burst of growth in response to expansionary monetary and fiscal policies, the lifting of sanctions, increases in global prices of Zimbabwe's major agricultural and mineral exports, and accelerated foreign borrowing. After five years of negative or zero growth, real GDP increased dramatically in 1980 and 1981 (see Table 1, p. 8).

The ambitious goals of the Growth with Equity Program were tempered by the realization among policymakers that the dualized nature of the economy could not be eliminated overnight without hurting the nation's agricultural and industrial base. Therefore, the government moved swiftly to redress a number of obvious inequities (for example, by providing increased job training to blacks and by initiating land redistribution schemes designed to place more land in the hands of communal farmers). But at the same time it was careful to protect the mining, manufacturing, and commercial agriculture sectors that comprised the backbone of the national economy. Agricultural producer prices were raised to stimulate increased output by commercial farmers, and resources were invested in the road and rail systems to repair damage sustained during the war.

Table 1. Macroeconomic indicators, Zimbabwe, 1965-85

Year	Population (million)	CPI (1980 = 100)	Real GDP (Z$ millions)	Real GDP per capita (Z$)	Inflation rate (%)
1965	4.49	44.20	1755	390.87	0.03
1966	4.63	45.60	1785	385.53	0.02
1967	4.79	46.60	1930	402.92	0.02
1968	4.96	47.30	1969	396.98	0.00
1969	5.13	47.50	2250	438.60	0.02
1970	5.31	48.40	2336	439.92	0.03
1971	5.50	49.90	2616	475.64	0.03
1972	5.69	51.30	2867	503.87	0.03
1973	5.89	52.90	2959	502.38	0.07
1974	6.08	56.40	3136	515.76	0.10
1975	6.14	62.10	3132	510.10	0.11
1976	6.33	68.90	3106	490.68	0.10
1977	6.52	76.00	2884	442.33	0.06
1978	6.72	80.30	2858	425.30	0.18
1979	6.93	94.90	2900	418.47	0.05
1980	7.14	100.00	3206	449.02	0.13
1981	7.36	113.10	3679	499.86	0.11
1982	7.55	125.20	3648	483.18	0.23
1983	7.74	154.10	3500	452.20	0.20
1984	7.98	185.20	3465	434.21	0.08
1985	8.30	200.90	3600	433.73	0.14

Data sources: USAID, CSO, IFS

In 1982, the fortunes of the Zimbabwean economy reversed dramatically as the result of a combination of adverse external and internal forces. The global recession reduced the demand for Zimbabwe's exports, depressing foreign exchange earnings and increasing the balance-of-payments deficit. Expected capital inflows from overseas failed to materialize, and the deficit had to be financed through high-cost commercial borrowing and drawdowns in foreign reserves. Meanwhile, a severe drought cut into the nation's ability to export agricultural commodities and necessitated imports of staple foodstuffs. Finally, increased wages, rapid expansion in government spending, and increased domestic credit fueled a burst of inflation. As a result of these convergent forces, GDP growth slowed dramatically (Table 2, p. 9).

Table 2. Annual growth rates in the Zimbabwean economy, 1965-85

	1966-70	1971-75	1976-80	1981-85
Population	2.9	2.3	2.6	2.6
Real GDP	6.2	3.9	0.6	(0.4)
Real GDP/C	2.8	1.4	(1.7)	(2.6)

Data sources: USAID, IFS

During the mid-1980s, the performance of the economy was mixed. Although significant progress was achieved in expanding education and health services to the majority of the population, in raising wage levels, and in redistributing land, many macroeconomic performance indicators continued to give rise to concern among policymakers. In spite of the fact that the current account deficit was decreased, strict foreign exchange controls restricted imports and added increased impetus to domestic inflation. Rising wage levels reduced the competitiveness of Zimbabwe's traditional exports, which coupled with the continuing stagnation of global commodities and mineral markets depressed exports. Meanwhile, lingering uncertainty about the future economic climate discouraged investment, with the result that anticipated infrastructural reconstruction did not materialize.

The Agricultural Sector in Zimbabwe

Even though the Zimbabwean economy is well diversified, with the agricultural sector contributing less than one-fifth of total GDP (see Table 3, p. 10), the strategic importance of agriculture should not be underestimated. In addition to providing a livelihood for approximately 50% of the population, the agricultural sector figures prominently in Zimbabwe's external trade picture. Tobacco, cotton, coffee, and other agricultural commodities over the years have averaged well over one-third of total exports by value, providing an important, if at times variable, source of foreign exchange earnings.

The nation's 391,000 square kilometers officially are divided into six ecological zones which differ in area, rainfall, soil type, and temperature. Natural Regions I, II, and III are dominated by large-scale commercial farms producing primarily cereals (maize, wheat, sorghum, barley), tobacco, cotton and/or oilseeds (groundnuts, cotton, soybeans,sunflower). Most communal or small-scale farming takes place in Natural Regions III and IV, with maize, cotton, tobacco, and groundnuts the main crops (see Figure 3, Table 4, p.11).

Table 3. Sectoral contribution to the Zimbabwean economy (real GDP % by industry of origin), 1969-84

Sector	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Agriculture and forestry	17.0	14.6	17.0	17.7	14.0	15.6	14.7	16.5	14.0	15.5	15.3	14.2	13.6	13.7	13.3	14.9
Mining and quarrying	9.7	10.3	10.1	9.5	10.2	9.4	9.6	10.5	10.7	10.2	10.1	8.8	7.4	7.8	8.0	8.3
Manufacturing	20.1	21.0	20.2	22.0	23.2	23.5	23.3	22.1	22.7	22.0	24.1	24.9	24.2	24.1	24.2	22.8
Electricity and water	4.0	4.0	3.9	3.1	3.7	2.9	3.0	2.7	2.0	2.5	2.2	2.2	1.9	1.7	1.9	2.0
Construction	4.6	4.6	4.7	4.8	5.4	5.3	5.0	4.0	3.8	3.1	3.1	2.7	2.7	2.7	2.5	2.6
Finance and insurance	3.4	3.7	3.9	3.9	4.2	4.5	6.1	6.2	6.7	6.0	5.1	4.9	5.7	6.6	6.0	5.6
Real estate	2.8	2.9	2.8	2.8	3.0	3.0	2.6	2.3	2.3	1.9	1.7	1.3	1.4	1.2	1.2	1.0
Hotels and restaurants	11.3	11.8	11.7	11.6	11.9	12.3	12.1	11.4	11.7	11.5	11.7	14.9	14.5	12.4	11.1	10.5
Transport and communication	7.3	7.9	7.7	7.5	7.1	6.7	6.3	6.1	5.7	5.8	6.0	6.5	6.6	6.5	6.3	6.0
Public administration and defense	6.7	6.5	6.0	5.6	5.7	5.6	6.3	7.1	8.5	9.7	9.6	9.0	9.3	9.1	9.5	10.2
Education services	5.0	4.6	4.2	4.0	4.2	4.1	4.3	4.3	4.8	4.4	4.4	5.2	6.5	7.8	8.8	9.3
Health services	2.1	2.1	2.0	2.0	2.0	1.9	2.0	2.0	2.4	2.4	2.4	2.2	2.4	2.4	2.6	2.6
Private domestic services	2.8	2.7	2.5	2.5	2.5	2.4	2.4	2.4	2.5	2.4	2.7	2.0	1.7	1.7	1.7	1.7
Other services	5.3	5.5	5.3	5.3	5.3	5.4	5.4	5.3	5.7	5.7	5.7	5.4	5.1	5.6	6.1	6.1
Less:																
Imputed banking service charges	(2.0)	(2.2)	(2.1)	(2.4)	(2.4)	(2.5)	(2.9)	(2.9)	(3.3)	(3.3)	(3.4)	(3.4)	(3.0)	(3.2)	(3.4)	(3.5)
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Source: IBRD

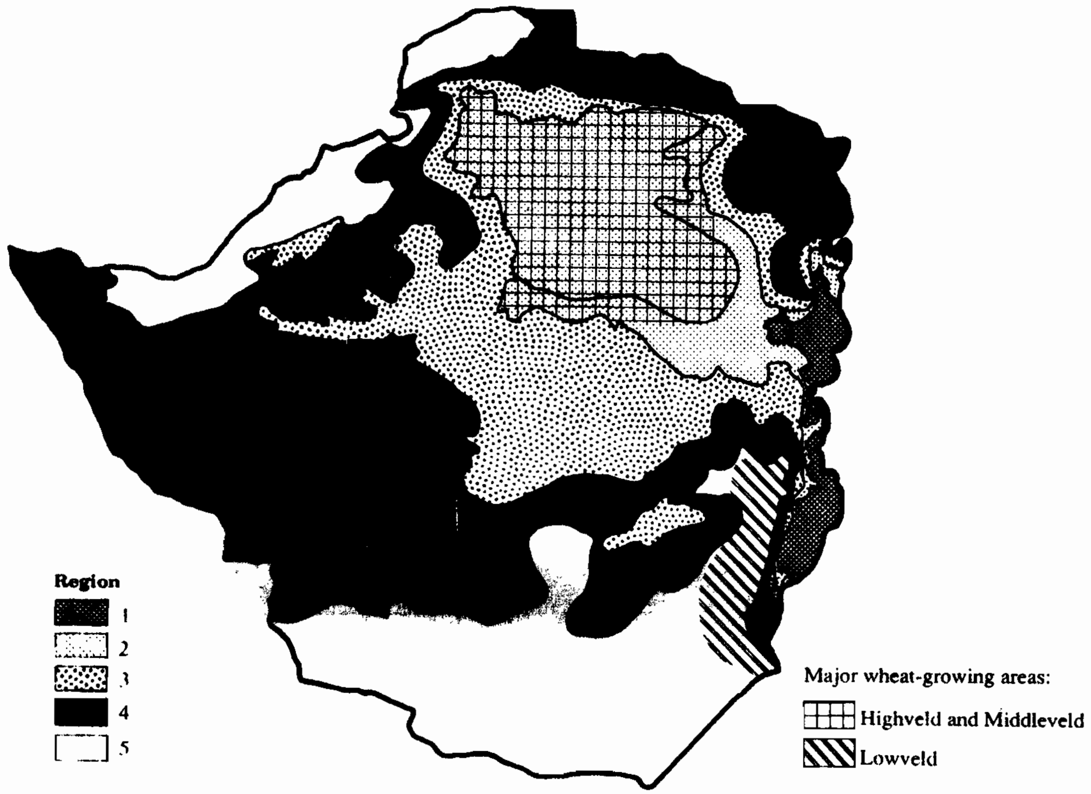

Figure 3. Map of Zimbabwe showing natural regions.

Table 4. Land classification and main agricultural uses

Region	Area (sq km)	Rainfall (mm)	Main agricultural uses
I	7,034	900-1200	Production of fruit, tea, coffee; intensive livestock production
II	58,614	750-100	Production of field crops, intensive livestock production
III	72,877	650-800	Production of fodder crops, cash crops, livestock; marginal production of maize, tobacco, cotton
IV	147,823	450-650	Production of drought-resistant crops; livestock production
V	104,411	< 450	Extensive livestock production, game ranching

Data source: Statistical Yearbook

Total production since 1965 of the principal commercial crops is shown in Table 5. Maize is produced by many commercial farmers and by virtually all communal farmers, except in the more arid southernmost parts of the country, where millet and sorghum predominate. Production of maize has on several occasions approached 3 million tons, although production variability is high because most of the crop is grown under rainfed conditions. After maize, the most important crops in quantitative terms are cotton, wheat, tobacco, soybeans, and groundnuts, all of which are grown both on commercial farms and in communal areas. Wheat, which can be grown only under irrigation during the cool and dry winter season, is planted primarily by commercial farmers, who account for approximately 95% of total production.

Table 5. Production of principal commercial crops, 1965-85

Year	Maize (t)	Wheat (t)	Cotton (t)	Tobacco (t)	Soybeans (t)	Groundnuts (t)
1965	822,000	3,810	-----	-----	200	-----
1966	900,000	8,878	-----	-----	200	-----
1967	1,517,590	14,051	-----	-----	400	-----
1968	975,436	26,222	-----	-----	2,300	-----
1969	1,571,520	38,938	-----	-----	7,600	-----
1970	980,000	56,235	85,803	54,509	8,598	36,468
1971	1,809,148	87,731	139,338	64,638	8,878	28,792
1972	2,266,523	82,241	165,347	67,139	10,231	34,693
1973	967,395	86,122	129,456	68,585	8,801	34,177
1974	2,124,774	89,926	190,065	74,637	21,819	205,463
1975	1,746,683	130,168	170,111	85,472	31,558	127,347
1976	1,786,123	147,165	142,116	109,018	44,905	192,430
1977	1,655,222	175,401	143,948	84,219	49,884	140,909
1978	1,618,392	203,903	166,101	83,434	78,535	113,599
1979	1,149,842	161,963	145,218	107,461	86,556	107,535
1980	2,813,150	191,234	157,553	120,049	97,403	77,675
1981	2,728,640	201,171	170,594	69,421	72,881	118,797
1982	1,785,800	213,000	134,886	89,197	91,596	111,377
1983	844,000	124,250	146,521	93,986	80,626	31,652
1984	1,283,000	98,505	221,746	116,931	89,733	19,875
1985	2,952,000	210,000	274,186	107,747	87,217	48,660

Data sources: CSO, AMA

All but one of the important commercial crops are sold to government marketing agencies or parastatals at official producer prices. (The only exception is tobacco, which is sold at auction to licensed private merchants.) Crop sales to the government marketing agencies since the 1969-70 marketing season are shown in Table 6. The quantities marketed of the various commercial crops roughly reflect their production levels. It should be pointed out that an important change occurred immediately following Independence in the source of officially marketed maize. Partly as a result of a one-time increase in production in the communal areas due to the return of refugees after the war, and partly as a result of the government's efforts to step up its marketing activities in communal areas, a significant increase occurred in 1984 and 1985 in the quantities of maize purchased by the Grain Marketing Board (GMB) in communal areas (Rohrbach 1987).

Table 6. Crop sales to marketing authorities, 1969/70-1984/85

Intake[a]	Maize (t)	Wheat (t)	Cotton (t)	Tobacco (t)	Soybeans (t)	Groundnuts (t)
1969-70	960,107	38,938	160,547	55,973	7,677	25,981
1970-71	610,686	56,235	99,039	51,399	7,348	11,637
1971-72	1,113,709	89,455	140,427	59,741	8,045	31,621
1972-73	1,420,725	81,626	170,727	60,892	8,461	81,173
1973-74	550,363	85,975	135,796	67,980	7,976	26,528
1974-75	1,336,855	90,449	164,722	71,620	19,053	44,416
1975-76	1,006,922	128,752	163,066	83,920	27,920	44,707
1976-77	958,532	147,854	131,566	110,533	44,824	46,608
1977-78	941,065	171,134	148,006	83,374	44,103	13,947
1978-79	877,026	207,997	173,914	82,969	69,746	17,696
1979-80	511,921	158,940	166,830	111,686	80,999	12,714
1980-81	819,168	163,040	182,037	122,572	93,636	17,425
1981-82	2,013,758	200,904	200,812	69,795	63,319	20,037
1982-83	1,391,265	212,945	157,673	86,949	84,340	15,905
1983-84	616,749	124,250	167,220	94,295	74,438	9,329
1984-85	941,590	98,530	250,072	119,636	89,775	5,706

Data source: MFEPD

a Intake is from April to March, except 1969-70 (May to April).

Despite the fact that communal farmers are entering the market in increasing numbers, most commercial agriculture in Zimbabwe continues to take place on large-scale farms featuring high levels of input use, extensive mechanization, and high levels of management. The performance of these commercial farms is impressive. During years of adequate rainfall, yields on commercial farms rival those achieved anywhere in the world, and Zimbabwe's two major export crops (tobacco and cotton) usually command quality premiums on world commodity markets.

Commercial farmers are very sensitive to profitability considerations, and this has implications for policy. Since many of the major commercial crops are close substitutes in production, commercial farmers are able to shift from one crop to another, with the result that official producer price policies tend to be very influential in shaping production patterns. Indeed, recent experience suggests that relatively minor adjustments to the structure of producer prices have been highly effective in bringing about extensive changes in cropping patterns on large-scale commercial farms. This feature of the commercial farming sector makes it especially important that Zimbabwean policymakers "get prices right" in establishing agricultural production priorities.

Wheat in Zimbabwe

Wheat was introduced into the area that is now Zimbabwe by European missionaries in the late 19th century, but it did not become an important crop until the Unilateral Declaration of Independence in 1965 reduced commercial grain imports and precipitated the need for self-sufficiency in basic cereals production (Ngobese 1987). The nation's 2,000 commercial wheat farmers responded to the challenge in remarkable fashion, creating a viable wheat industry in an extremely short period. Historical data indicate that the increase in production, which occurred between 1965 and 1980, resulted both from increases in area planted to wheat, as well as from a strong upward trend in yields (Table 7, p. 15).

Several factors made the development of a domestic wheat industry possible. First, climatic conditions in Zimbabwe are generally favorable for irrigated wheat production. Whereas much of sub-Saharan Africa is too hot for wheat, most wheat in Zimbabwe is grown in the Middleveld and Highveld regions, where temperatures during the winter months range from 0-20°C, well within the limits tolerated by the crop. Second, the similarity in production technologies between wheat and other crops grown in Zimbabwe made it relatively easy for commercial farmers to shift into wheat. Much of the machinery needed for land preparation, fertilizer and pesticide application, and irrigation of wheat was already available, which reduced the time required to switch to wheat production. Third, government policies created strong incentives for commercial farmers to take up wheat production. During the latter half of the 1960s, producer prices for wheat were maintained above import parity prices, and subsidized credit programs were introduced to promote wheat production.

Table 7. Zimbabwe wheat data, 1965-86

Year	Area harvested (ha)	Average yield (t/ha)	Wheat production (t)	Wheat consumption (t)	Net imports (t)	Bread price (1980 Z$/loaf)
1965	1,619	2.69	3,810	84,000	80,190	----
1966	4,419	2.23	8,878	108,000	99,122	----
1967	5,222	2.81	14,051	99,000	84,949	----
1968	7,325	3.37	26,222	109,000	82,778	0.23
1969	12,039	3.48	38,938	114,000	75,062	0.23
1970	15,322	3.67	56,235	116,000	59,765	0.25
1971	23,688	4.02	87,731	119,000	31,269	0.24
1972	24,276	3.73	82,241	111,000	28,759	0.23
1973	22,620	3.94	86,122	130,000	43,878	0.23
1974	26,819	3.71	89,926	141,000	51,074	0.23
1975	32,569	3.95	130,168	146,000	15,832	0.24
1976	34,282	4.31	147,165	120,000	(27,165)	0.23
1977	44,817	3.93	175,401	125,000	(50,401)	0.24
1978	47,708	4.53	203,903	144,000	(59,903)	0.24
1979	36,868	4.46	161,963	169,000	7,037	0.21
1980	38,461	4.75	191,234	205,000	13,766	0.21
1981	36,845	5.01	201,171	223,000	21,829	0.21
1982	37,378	5.14	213,000	234,000	21,000	0.21
1983	23,000	5.16	124,250	227,000	102,750	0.21
1984	17,000	5.20	98,505	220,000	121,495	0.21
1985	38,037	5.40	205,484	248,000	42,516	0.22
1986	43,184	5.75	248,347	270,000	21,653	0.23

Data sources: FAO, CSO, CFU

Despite the rapid growth in domestic wheat production, consumption of wheat in Zimbabwe has grown even more rapidly. As shown in Table 7, total wheat consumption tripled during the past two decades, and consumption per capita rose by roughly half. The forces underlying this rapid increase in consumption appear similar to those found elsewhere in sub-Saharan Africa and in much of the developing world, such as rising incomes, increasing urbanization, changes in consumer tastes and preferences, and decreases in the consumer price of wheat relative to substitutes (Byerlee and Morris 1987; Byerlee 1987; Byerlee and Sain 1986; Byerlee and Longmire 1986). Yet in spite of the rapid growth in demand, consumer price policy has not been used in Zimbabwe to discourage wheat consumption; retail bread prices have been kept constant in real terms over the past two decades (Table 7). With the demand for bread and other wheat-based products exceeding supply, the government has relied instead on import controls and rationing to limit consumption.

While aiming for a policy of self-sufficiency in wheat, Zimbabwe has not hesitated to rely upon world markets to dispose of occasional surpluses or, more commonly, to make up domestic production shortfalls. Zimbabwe actually exported modest quantities of wheat during the late 1970s, but demand has since outpaced supply, forcing the government to import (Table 7). Wheat imports increased rapidly during 1984 and 1985 after several years of drought reduced the local harvest. Although production has since showed signs of recovering to long-term trend levels, the goal of self-sufficiency remains elusive (Figure 4).

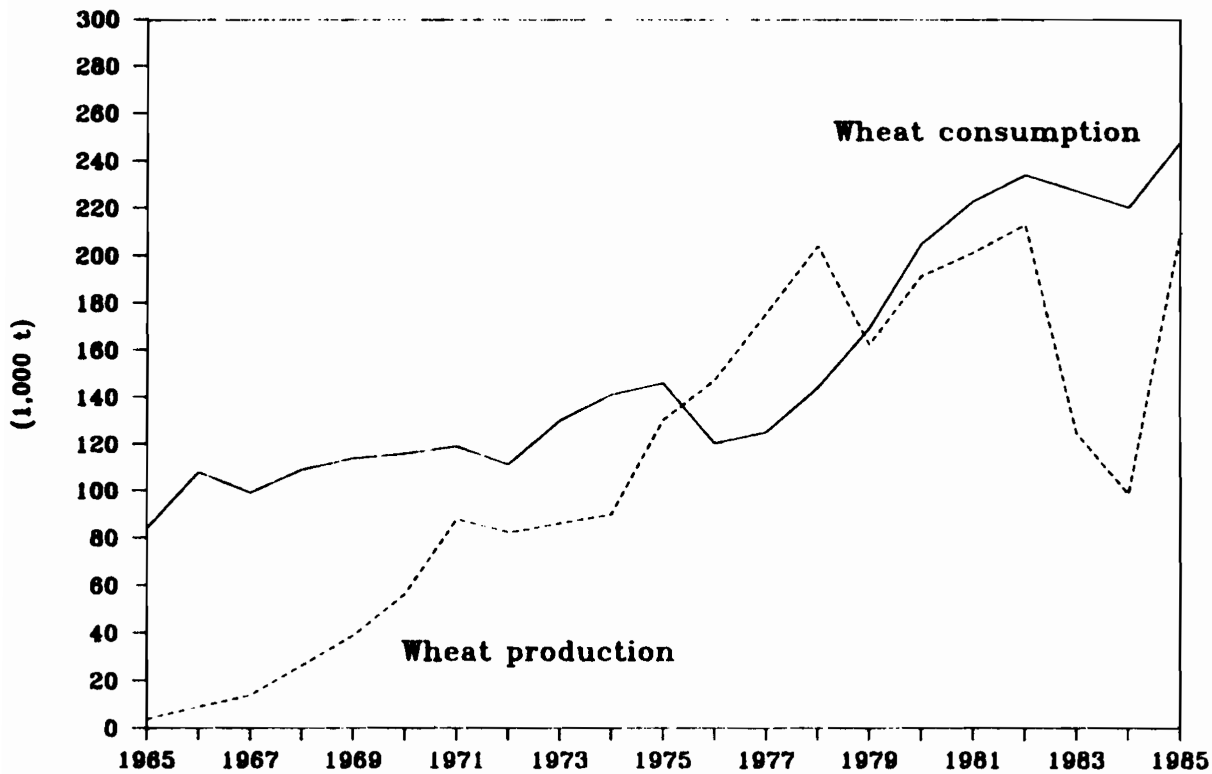

Figure 4. Production and consumption of wheat in Zimbabwe, 1965-85.

Agricultural Pricing Policies and Producer Incentives

Market Prices vs. Social Prices

Prices used in the profitability calculations are based mainly on 1986 prices, although other prices (for example, projected year 2000 prices) are also used in conducting sensitivity analysis. As indicated earlier, the DRC framework for assessing comparative advantage requires that the profitability of alternative enterprises be calculated twice: first, using market prices for inputs and outputs (to determine private profitability); and second, using social prices (to determine social profitability or efficiency). Differences between market prices and social prices, if they are present, can be attributed to government policies or market failures.

In estimating social prices for tradables, it is important to take into account Zimbabwe's exchange rate policy. A combination of factors, notably sluggish growth in Zimbabwe's major agricultural and mineral exports along with depressed world prices, has in recent years reduced the nation's export earnings and precipitated a severe foreign exchange shortage. The government has responded to this crisis by instituting a set of foreign exchange controls, including a system of rationing foreign exchange to "essential industries." One effect of this policy has been to allow the government to maintain an overvalued currency. Currently, the official exchange rate does not fully reflect the real value of a unit of foreign currency to the Zimbabwean economy. Economists in government and at the University of Zimbabwe estimate that the Zimbabwe dollar may be overvalued by as much as 30% in relation to the US dollar, based on differential rates of inflation between Zimbabwe and its major trading partners (O'Driscoll 1987). World Bank analysts, while conforming to Bank practice in using a "zero foreign exchange premium" for purposes of project appraisal, apply conversion factors to adjust for exchange-rate induced distortions in the trade regime, labor market, and transport and energy sectors that imply an overvaluation on the same order of magnitude (Watson 1987).

The overvaluation of domestic currency is important in comparative advantage analysis because it affects the market prices of tradables. Imported goods become cheaper in domestic currency because they can be purchased with fewer units of the overvalued domestic currency, whereas exports become more expensive for foreign buyers because more units of the undervalued foreign currency are required to pay for them. Consequently, if adjustments are not made to correct for domestic currency overvaluation, efficiency analysis will be biased in favor of import-intensive activities.

In calculating social prices for the present study, the import content of all tradables is valued using a shadow exchange rate. An exchange rate conversion factor of 1.3 is used to convert from the official exchange rate to the shadow exchange rate, to offset an estimated 30% overvaluation of the Zimbabwe dollar. The use of this conversion factor based on the differential rates of inflation is justified, since no parallel market exists for foreign exchange.

Product Prices

Real producer prices for wheat and major competing crops are shown in Table 8. Recent price policy for each of these crops is discussed briefly in the sections below.

Table 8. Real producer prices of principal crops, 1965-86

Year	Wheat (AS) (Z$/t)	Maize (A) (Z$/t)	Cotton (seed) (c/kg)	Soybeans (A) (Z$/t)	Groundnuts (shelled) (Z$/t)	Tobacco (flue) (c/kg)
1965	141.29	77.01	33.26	----	----	138.01
1966	136.27	63.07	32.24	----	----	94.30
1967	150.56	62.51	33.50	----	----	109.44
1968	151.48	68.77	33.00	172.52	----	107.82
1969	149.98	65.20	31.94	176.59	----	96.84
1970	143.49	68.12	31.34	173.47	----	95.04
1971	138.86	60.22	32.75	169.02	262.48	102.20
1972	134.52	50.45	35.67	142.46	254.95	99.42
1973	130.78	68.75	50.26	154.65	292.31	103.97
1974	141.65	71.12	49.65	193.99	341.12	138.30
1975	177.13	59.58	42.27	165.70	402.58	111.11
1976	175.62	63.68	52.08	149.35	319.93	108.85
1977	161.84	68.42	43.42	170.07	362.84	107.89
1978	136.99	66.00	41.10	174.66	367.37	123.29
1979	121.18	63.75	35.83	152.79	347.73	86.41
1980	135.00	85.00	37.50	160.00	360.00	79.00
1981	145.89	106.10	35.37	150.31	344.92	162.48
1982	151.76	95.85	41.13	159.74	335.46	133.64
1983	142.76	77.87	33.42	168.72	292.02	122.36
1984	134.99	75.59	30.78	154.97	242.98	106.12
1985	141.86	89.60	33.35	159.28	248.88	133.83
1986	133.87	80.32	33.47	151.72	334.67	142.66

Data sources: MLARR, MFEPD, AMA, USDA

Wheat--Following ten years of relative stagnation, the real producer price for wheat rose 25% in 1975 as the government reacted to tightening economic sanctions by attempting to accelerate the growth rate of domestic wheat production. However, this gain has since been lost, and the real producer price today is actually below its 1965 level (Table 8).

The wheat producer price is established at the Cabinet level, generally conforming to a recommendation made by the Ministry of Lands, Agriculture, and Rural Resettlement (MLARR). This recommendation is based on cost-of-production data provided by farmers' organizations, as well as on marketing cost data furnished by the Agricultural Marketing Authority (AMA). Since Independence, the government apparently has attempted to set wheat producer prices to provide just enough incentive to encourage most farmers to make full use of existing irrigation potential (Jansen 1982).

Since wheat is the only major commercial crop adapted to the cool winter growing season, most farmers have no real alternative to growing wheat during the winter months. (Some barley is grown under contract for the breweries, but this market is limited. Another alternative would be to grow wheat or barley for use as livestock feed, but this is unprofitable at current livestock prices.)

The wheat industry in Zimbabwe has received little direct protection. The wheat producer price has remained close to the level of the world price for wheat (import parity price), once adjustments are made for transportation and handling costs. During the past 15 years, the nominal protection coefficient for wheat (calculated using the official exchange rate) has fluctuated around unity, suggesting that producer price policy has neither taxed nor subsidized wheat farmers in a consistent manner (Table 9, p. 20).

Maize--The real producer price of maize has changed very little over the past 20 years; periodic price increases were subsequently eroded by inflation (Table 8). After a long period of stagnation, the real producer price for maize was increased considerably following Independence, jumping 33% in 1980 and another 25% in 1981. These drastic price increases had a dual purpose: to restore self-sufficiency in the nation's staple food crop, and to raise income levels in the communal farming sector. Producers responded markedly to these price changes, which were implemented along with a number of production-support and market-improvement measures (Rohrbach 1987). Crop sales to marketing authorities quadrupled over two years, increasing from 512,000 t in 1979-80 to 2,014,000 t in 1981-82, leaving GMB with an enormous maize surplus.

Table 9. Nominal protection coefficients on wheat in Zimbabwe, 1970-86

Year	(1) HRW #2 wheat (FOB Gulf) (WWS) (US$/t)	(2) Ocean freight (Gulf to E. Africa (WWS) (US$/t)	(3) Border price (Durban) (1)+(2) (US$/t)	(4) Official US$:Z$ exchange rate (IFS)	(5) Border price (Durban) (3)/(4) (Z$/t)	(6) Zimbabwe CPI (CSO) (1980=100)	(7) Transport and handling (Durban to Harare) 22*6 (Z$/t)	(8) World wheat price Harare (5)+(7) (Z$/t)	(9) GMB transport and handling costs 10*(6) (Z$/t)	(10) Transport (depot to farm) 2.5*(6) (Z$/t)	(11) World wheat price at farm (8)-(9)-(10) (Z$/t)	(12) Official producer price of wheat (CSO) (Z$/t)	(13) Nominal protection coefficient (12)/(11)
1970[a]	60	11	71	1.40	51	0.484	11	61	5	1	55	69	1.2556
1971	60	6	66	1.52	43	0.499	11	54	5	1	48	69	1.4387
1972	91	12	103	1.52	68	0.513	11	79	5	1	73	69	0.9501
1973	177	40	217	1.65	132	0.529	12	143	5	1	137	69	0.5067
1974	164	32	196	1.82	108	0.564	12	120	6	1	113	80	0.7067
1975	152	19	171	1.60	107	0.621	14	121	6	2	113	110	0.9748
1976	113	18	131	1.62	81	0.689	15	96	7	2	88	121	1.3778
1977[a]	116	19	135	1.55	87	0.760	17	104	8	2	95	123	1.2996
1978[a]	141	21	162	1.48	110	0.803	18	127	8	2	117	110	0.9381
1979[a]	174	42	216	1.48	146	0.949	21	167	9	2	155	115	0.7432
1980[a]	182	49	231	1.59	146	1.00	22	168	10	3	155	135	0.8691
1981	171	43	214	1.39	154	1.131	25	178	11	3	164	165	1.0041
1982	159	35	194	1.09	179	1.252	28	206	13	3	191	190	0.9972
1983	154	37	191	0.90	211	1.541	34	245	15	4	226	220	0.9742
1984	148	38	186	0.67	280	1.852	41	321	19	5	297	250	0.8406
1985	129	38	167	0.61	274	2.009	44	318	20	5	293	285	0.9721
1986	108	34	142	0.60	237	2.241	49	286	22	6	258	300	1.1630

a Zimbabwe a net exporter of wheat.

b Real cost assumed constant at Z$ 22.00.

c Real cost assumed constant at Z$ 10.00.

d Real cost assumed constant at Z$ 2.50.

Data sources: WWS = World Wheat Statistics; IFS = International Financial Statistics; CSO = Central Statistical Office.

The Zimbabwean maize industry has received little direct protection. The maize producer price has remained close to or slightly below the world price (export parity price), once adjustments are made for transportation and handling costs. Since Independence, the nominal protection coefficient for maize (calculated using the official exchange rate) has fluctuated around unity, indicating that producer price policy has neither taxed nor subsidized maize farmers in a consistent manner (Table 10, p. 22). In years of significant producer price increases such as 1980, the protection coefficient has risen above 1, precipitating a surge in maize production and resulting in a surplus that could be exported only at a loss to GMB.

Cotton--The real producer price for cotton enjoyed a succession of favorable years during the mid-1970s, but since then it has fallen back to its 1965 level (Table 8). Cotton production is being actively promoted by the government for three reasons: 1) cotton lint is a valuable foreign exchange earner; 2) cotton is an important cash crop for communal farmers; and 3) cotton production provides jobs for as many as half a million people. In part because of its drought-resistant qualities, cotton has proven to be a particularly valuable crop for the communal sector, which now accounts for well over half of total sales to the Cotton Marketing Board (CMB).

To encourage increased production in the face of high variability in world cotton prices, CMB guarantees stable producer prices which in certain years entail an explicit subsidy to growers. The producer price structure includes considerably higher prices for grade A quality lint, which earns a significant premium in foreign markets. Approximately 70-75% of Zimbabwe's total lint production is exported, at prices generally 15-20% higher than the Liverpool index price (representing the quality premium).

Groundnuts--Data on official producer prices for groundnut must be interpreted with caution, because nearly 90% of total groundnuts production occurs in communal lands, where most of the crop is retained for home consumption or local sale (Makombe, Bernsten, and Rohrbach 1987; Mudimu 1987). Commercial farmers generally have not grown groundnuts because of the large amount of labor needed for harvesting. Thus, sales to GMB at official producer prices have been extremely low relative to total production.

Most of the commercial groundnut crop is sold to GMB as grade A1 shelled nuts, which are sorted into three classes: 1) seed, 2) hand-picked specials (used for confectionary purposes), and 3) crushers. The official producer price for grade A1 nuts increased during the mid-1970s, but has since lost ground to inflation (Table 8).

Table 10. Nominal protection coefficients on maize in Zimbabwe, 1978-86

Year	(1) # 3 Yellow maize (FOB Gulf) (IBRD) (US$/t)	(2) Ocean freight (Gulf to E. Africa) (WWS) (US$/t)	(3) Border price (Maputo) (1)+(2) (US$/t)	(4) Add quality premium (10%) (US$/T)	(5) Official US$:Z$ exchange rate (IFS)	(6) Border price (Maputo) (4)/(5) (Z$/t)	(7) Zimbabwe CPI (CSO) (1980=100)	(8)[b] Transport (Maputo to Bindura) 18*(7) (Z$/t)	(9)[c] GMB handling costs 10*(6) (Z$/t)	(10)[d] Transport (Bindura to farm 2.6*(6) (Z$/t)	(11) World maize price at farm (6-8-9-10) (Z$/t)	(12) Official producer price of maize (CSO) (Z$/t)	(13) Nominal protection coefficient (12)/(11)
1970[a]	58	11	69	75	1.40	54	0.484	9	5	1	39	33	0.8458
1971[a]	58	6	64	70	1.52	46	0.499	9	5	1	31	30	0.9696
1972[a]	56	12	68	74	1.52	48	0.513	9	5	1	33	26	0.7896
1973[a]	98	40	138	148	1.65	90	0.529	10	5	1	73	36	0.4952
1974[a]	132	32	164	177	1.82	97	0.564	10	6	1	80	40	0.5003
1975[a]	120	19	139	151	1.60	94	0.621	11	6	2	75	37	0.4918
1976[a]	112	18	131	142	1.62	88	0.689	12	7	2	67	44	0.6582
1977[a]	95	19	114	124	1.55	80	0.760	14	8	2	57	52	0.9119
1978[a]	101	21	122	132	1.48	89	0.803	14	8	2	65	53	0.8188
1979[a]	116	42	158	169	1.49	114	0.949	17	9	2	85	61	0.7108
1980	125	49	175	187	1.59	118	1.000	18	10	3	87	85	0.9717
1981[a]	131	43	174	187	1.30	134	1.131	20	11	3	100	120	1.2044
1982[a]	109	35	145	156	1.09	143	1.252	23	13	3	105	120	1.1451
1983[a]	136	37	173	187	0.90	206	1.541	28	15	4	159	120	0.7532
1984	136	38	174	188	0.67	282	1.852	33	19	5	226	140	0.6206
1985[a]	112	38	150	161	0.61	265	2.009	36	20	5	204	180	0.8839
1986[a]	88	34	122	130	0.60	217	2.241	40	22	6	149	180	1.2087

a Zimbabwe a net exporter of maize.

b Real cost assumed constant at 1980 Z$ 18.00

c Real cost assumed constant at 1980 Z$ 10.00

d Real cost assumed constant at 1980 Z$ 2.50

Data sources: WWS (World Wheat Statistics); IFS (International Financial Statistics); CSO (Central Statistical Office); IBRD (World Bank).

Soybeans--Soybeans are grown primarily by commercial farmers, with most of the crop going to the domestic vegetable oil processing industry. Since 1968, real producer prices have declined (Table 8).

Government price policy for soybeans seems designed mainly to maintain self-sufficiency. Soybeans are used primarily for human consumption in Zimbabwe, and producer price increases have been introduced only when demand for vegetable oils has threatened to outstrip supply. The GMB has made little effort to promote soybeans as an export crop, perhaps in reaction to fierce competition in world markets. The fact that soybeans are grown by very few communal farmers may also have contributed to their relative neglect by the government since Independence. On the other hand, the recent overproduction of maize has created renewed interest in soybeans as a potential export crop that would permit commercial farmers to diversify out of cereals.

Tobacco--Government participation in tobacco marketing is restricted to a regulatory function, so the producer price of tobacco is not set directly the way it is for other crops. Producer prices for tobacco are established through an auction system, whereby licensed private traders purchase the crop directly from producers. Prices are highly sensitive to world market conditions and vary considerably depending on the quality of the leaf. Real producer prices have remained flat over the long run, although they have shown considerable variability due to the sensitivity of the auction system to short-term market conditions (Table 8).

Input and Factor Prices

The prices of many agricultural inputs in Zimbabwe are influenced directly or indirectly by government policies, including taxes, subsidies, import tariffs, export controls, quotas, marketing regulations, minimum wage legislation, and exchange rate controls. In the sections that follow, input and factor prices are briefly reviewed, and selected government policies affecting the profitability of commercial farming are discussed.

Seed--Zimbabwe has a well-developed private seed industry that produces adequate supplies of high-quality seed for the major commercial crops. The government does not regulate the industry; seed prices are market-determined and appear to reflect production costs plus a normal profit margin. Most seed is produced by private farmers working under contract to one of the seed companies. The rate of varietal turnover is high, because public as well as private research organizations are actively engaged in breeding programs that continuously produce new varieties for release. The efficiency of the seed industry is reflected in the widespread use of improved material. Virtually all wheat area is planted to high-yielding, semidwarf varieties, and approximately 77% of total maize area is planted to improved varieties (the percentage is much higher on commercial farms) (Young 1987).

Fertilizer--The fertilizer industry in Zimbabwe consists of four private companies (two importer/manufacturers and two distributors) whose operations and pricing policies are regulated by the government. Of the materials used to manufacture fertilizers, some are produced in Zimbabwe and some are imported. Nitrogen and phosphorus fertilizers are manufactured locally, but existing capacity is insufficient to satisfy total demand, necessitating imports in most years. Potash deposits do not exist in Zimbabwe, so all potassium used by the fertilizer industry is imported.

Because fertilizer is classified as an "essential commodity," its pricing structure is subject to government regulation. Pricing of fertilizers is determined at the Cabinet level, based on recommendations developed through negotiations involving government ministries and industry representatives. The recommendations made to the Cabinet take into account numerous factors, including costs of raw materials, manufacturing costs and margins, distribution costs and margins, farmers' estimated costs of production, and anticipated effects of fertilizer price policy on the national budget (FAO FIAC 1986).

Real retail prices for selected single-element and compound fertilizers appear in Table 11, p. 25. The policy of cross-subsidizing fertilizers was removed in 1975, resulting in a substantial increase in the prices of some fertilizers in that year. Since 1975, fertilizer price movements in Zimbabwe have more or less reflected changes in production costs, although the fact that price changes are not enacted every year has resulted in a stepwise adjustment process. Despite the overall slow rate of growth, fertilizer prices have risen more rapidly than crop prices. For example, since 1970 the nitrogen:wheat price ratio has increased from slightly under 3 to around 4 (Figure 5, p. 26).

Market prices for fertilizers are directly influenced by government policies. In 1986, retail fertilizer sales were exempted from sales tax; however, fertilizer imports and imports of materials used in manufacturing fertilizers were subject to an import tariff of 20% on the FOB price.

Table 11. Real retail fertilizer prices (1980 Z$/t) in Zimbabwe, 1970-85

Fertilizer	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Ammonium nitrate	131	127	123	119	132	205	169	170	173	149	168	166	165	134	165	203
Urea	113	111	108	105	118	147	144	139	142	135	154	221	220	179	221	269
Double super phosphate	131	141	137	133	144	149	171	182	187	182	204	204	214	174	203	239
Single super phosphate	67	65	63	61	67	71	83	83	84	80	90	103	115	93	107	127
Sulphate of potash	146	141	138	133	152	231	190	157	156	175	202	211	214	174	203	267
Muriate of potash	113	117	113	110	127	191	144	118	114	128	155	162	155	126	136	175
Compound D (8-14-7)	113	111	108	105	118	147	144	139	142	135	154	149	151	123	143	177
Compound L (5-18-10)	120	114	111	108	121	152	148	121	123	118	135	167	171	139	164	201
Nitrogen (ammonium nitrate)	378	367	357	346	381	595	490	494	501	432	488	480	479	389	480	586

Data source: MLARR

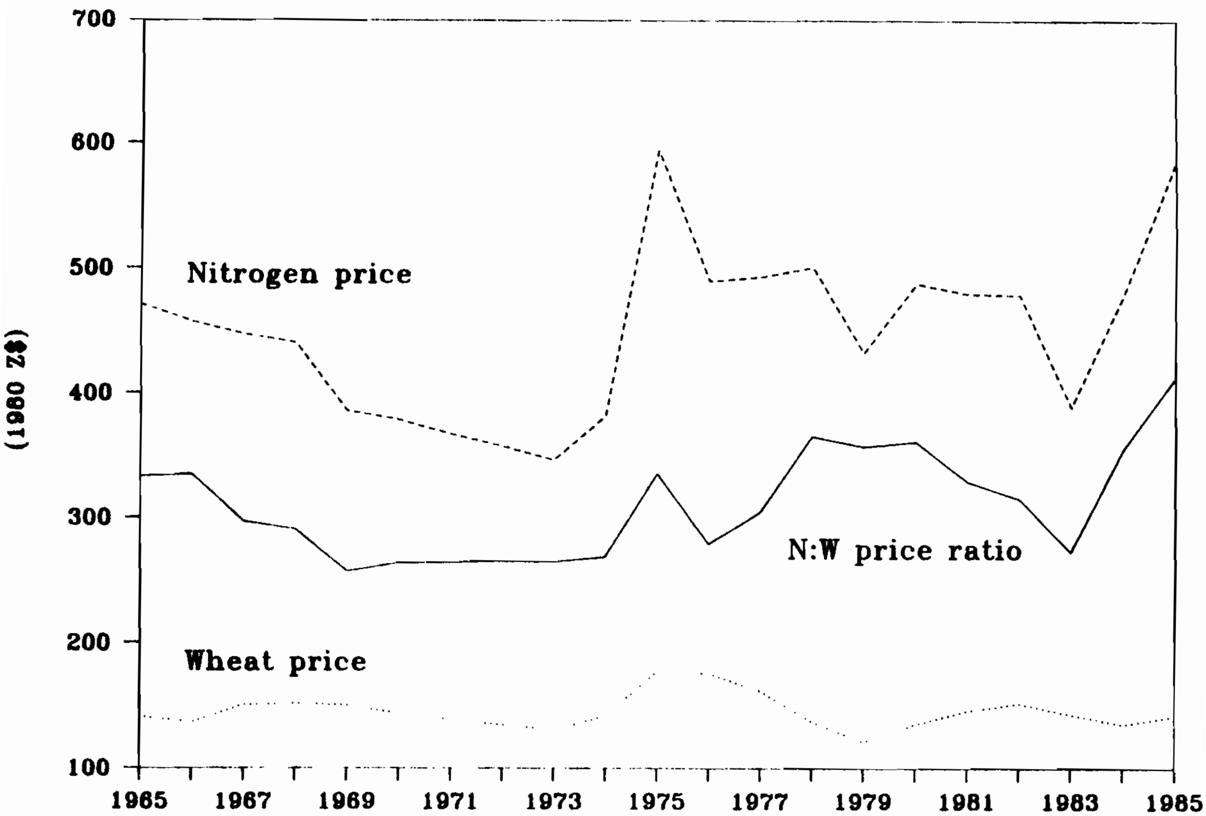

Figure 5. Nitrogen : wheat price ratio in Zimbabwe, 1965-85.

Crop chemicals--Crop chemicals (e.g., herbicides, fungicides, and insecticides) comprise an important cost category for many commercial farmers, especially since high labor costs often encourage the use of chemicals to clear land and control weeds. Most crop chemicals are imported into Zimbabwe by one of several authorized crop chemical distributors, who distribute them to farmers at government-regulated prices. Recent increases in world market prices for agrochemicals have resulted in significant increases in domestic prices.

In 1986, the official pricing structure for crop chemicals was similar to that for fertilizers: although retail sales of crop chemicals were exempted from sales tax, all imports were subject to a 20% import tariff.

Farm machinery--Prices of farm machinery are critically important in Zimbabwe because a high degree of mechanization characterizes commercial farms. Tractors (and for some crops, combine harvesters) are indispensable to commercial farming operations and account for an important proportion of crop production costs. Since neither tractors nor combine harvesters are manufactured in Zimbabwe, all have to be imported, along with a wide selection of spare parts. Consequently, their availability and cost is determined by government policies affecting exchange rates, foreign currency allocation, import tariffs, and sales taxes.

The current foreign exchange shortage clearly has had an impact on the availability and cost of farm machinery. Tractor and combine sales have suffered a marked decline since Independence, and machinery dealers report lengthy waiting lists for every size of tractor and harvester. Spare parts are also in short supply, and many types of machinery are periodically idled for want of a relatively inexpensive replacement part. Hoping to protect themselves against future contingencies, farmers have responded by stockpiling spare parts and by purchasing unneeded tractors or harvesters when they become available. At the same time, the working life of many tractors and combines has been considerably extended. The current average age of the nation's combine fleet is somewhere in the range of 12-15 years, extremely high by global standards. The continuing use of antiquated machinery has resulted in an exponential increase in repairs and maintenance costs.

Government policies directly affect the prices of imported machinery. In 1986, tractors, combines, and machinery spares were subject both to import tariffs (5%, 5%, and 20% respectively) as well as to retail sales taxes (20%, 20%, and 12.5% respectively).

Capital budgets used to calculate farm machinery costs for use in the crop budget analysis appear in Appendix A. The hourly operating cost figures obtained from the prototypical machinery budgets are consistent with actual contract hire charges, once allowance is made for a normal profit margin accruing to providers of contract hire services.

Irrigation--Irrigation costs can be subdivided broadly into two categories: the cost of water storage (including dam construction and purchase of a pump) and the cost of installing an irrigation system (including purchase of pipes and fittings, as well as system assembly).

The cost of water storage varies depending on the source. Irrigation water in Zimbabwe comes from two primary sources: public water is pumped from major rivers or public reservoirs, whereas private water is obtained from own-farm dams. Farmers possessing rights to public water are assessed a so-called "blend" charge designed to recover the actual costs of constructing and maintaining public reservoirs. Those without rights to public water, or with rights to a limited amount of public water, must construct farm dams.

Since all public water is currently being used, farmers desiring to develop additional irrigation capacity construct their own farm dams. Projecting the future cost of private water storage is difficult, because many of the more suitable locations for farm dams have already been exploited; thus, increasing technical sophistication will be required to develop the remaining sites (Mitchell 1986). Capital budgets used to calculate irrigation investment costs for use in the crop budget analysis appear in Appendix A, based on 1986 prices furnished by a leading private irrigation consultant. The initial investment cost of Z$ 5,000/ha (for dam, pump, and irrigation equipment) is consistent with figures cited by farmers and irrigation credit lenders.

The cost to farmers of irrigation is directly affected by several government policies. Although most irrigation pumps are locally manufactured, those that are imported are assessed a tariff of 20%. In addition, all pumps, whether locally manufactured or imported, are subject to sales tax of 20%. Irrigation pipes and fittings, which are all locally manufactured and therefore immune from import tariffs, are exempted from sales tax.

Irrigation investment costs for some commercial farmers are affected by a subsidized government credit program targeted specifically at wheat producers. First established in 1965 and reintroduced in 1985 after having been suspended for several years, the National Farm Irrigation Fund (NFIF) extends low-cost loans to finance irrigation development, with the condition that any area developed with NFIF funding be used for wheat production during the duration of the loan. (This is an important condition; many farmers would gladly accept NFIF funding to develop irrigation solely for tobacco and cotton production.) The NFIF loan rate currently stands at 9.75% per annum, as compared to commercial lending rates of 16-18% per annum.

Fuel and lubricants--The two major types of fuel used by farmers are diesel (to run farm machinery) and electricity (to run irrigation pumps and drying facilities). The agricultural sector uses approximately 25% of the diesel fuel consumed in Zimbabwe. The 1986 wholesale price of 60.4 ¢/l includes a government excise tax of 11.8 ¢/l. Electricity is provided to farmers by the Zimbabwe Electricity Supply Authority (ZESA), a parastatal organization. Farmers are classified as industrial users under ZESA's multi-rate pricing structure. While the precise cost of electricity used in irrigation varies as a function of individual farmers' specific consumption patterns, for purposes of this study an average electricity cost of Z$ 34/1000 m^3 has been used for 1986, based on the figures cited in AGRITEX and CFU budgets. Since the electricity pricing structure in Zimbabwe is based on actual electricity production costs, this figure does not reflect any major policy-induced distortions.

Production credit--Production credit in Zimbabwe is provided by both public and private lenders. A government organization, the Agricultural Finance Corporation (AFC), extends some short-term credit, while in the private sector agricultural cooperatives and commercial banks both are active lenders to the farming community. Production credit is handled in roughly equal quantities by all three types of lenders.

Production credit extended through the public lending agency, the AFC, is subsidized. In recent years, the AFC loan rate has typically been 3-5 points below the rates offered by commercial banks for equivalent loans. In 1986, the AFC loan rate stood at 13.9% per annum (13% interest and 0.9% compulsory insurance), whereas most agricultural loans at commercial banks were issued at 16-18% per annum. Domestic inflation in 1986 was running at around 12.5% annually, so the real rate of interest on AFC loans was only about 1%, and the real rate of interest on commercial loans 3-5%.

Insurance--Most commercial farmers in Zimbabwe insure part of their cash crops against damage or loss due to fire or weather (especially hail). Coverage is provided by private insurance companies, with terms of the policies usually negotiated by the relevant producers' group. Premiums are assessed as a percentage of the gross value of production. The rates used in this study for the 1986 reference year range from a low of 0.35% for wheat to a high of 4.85% for tobacco. (These rates assume that commercial farmers typically do not purchase the maximum possible insurance coverage, reflecting actual practice.)

Transport--To the extent that farmers hire transport to move inputs to their farms and to deliver outputs to markets, the profitability to farmers of crop production is affected by transport costs. And to the extent that equivalent world prices of tradable goods are affected by domestic transport charges, the social profitability of crop production is also affected.

Two types of transport--road and rail--are important in the agricultural sector. Whereas road transport costs are largely market determined, rail transport costs are administratively set and contain a subsidy estimated at approximately 30% (based on MFEPD data on the railways' net operating losses). Consequently, for purposes of this study, all rail transport charges occurring within Zimbabwe are adjusted upward by a conversion factor of 1.3.

Research and extension--Prior to Independence, research and extension services in Zimbabwe were oriented mostly toward the large-scale commercial farming sector. Today, a concerted effort is being made to shift the focus of government research and extension organizations toward activities of interest to small-scale commercial and communal farmers (Mugabe 1984).

The commercial farming sector has responded to the reorientation of government research and extension services by developing a set of privately funded institutions to continue conducting research of interest to commercial farmers and propagating the results. Levies averaging 0.5-1% of the gross value of production are exacted from all commercial farmers and are used to finance research and extension activities. A portion of the money covers the operating costs of the Agricultural Research Trust (ART) Farm outside Harare, which conducts research on crops of current or potential interest to the commercial farmer. Another portion is used to finance the various commercial producer associations within CFU. In addition to representing commercial farmers in the agricultural policy dialogue, CFU also engages in a wide range of extension and market development activities.

Labor--Wage reform legislation enacted in 1981 raised the minimum wage rate for agricultural workers and stipulated mandatory non-wage contributions to be provided by employers (including such items as protective clothing, housing and lighting allowances, workman's compensation, and pension). For purposes of this study, a weighted average cost of labor was used, including both wages and non-wage contributions. In 1986, this cost stood at Z$ 4.75/day for skilled workers (e.g., foremen, drivers) and Z$ 3.83/day for unskilled workers (e.g., ordinary field hands). These figures, whose derivation is shown in Table 12, are consistent with the figures used by MLARR, AGRITEX, and CFU.

Table 12. Derivation of agricultural labor costs, 1986

Worker category	Annual wage (Z/$)	Lighting allowance (Z/$)	Workmen's comp. (Z/$)	Pension (Z/$)	Protective clothing (Z/$)	Annual total (Z/$)	Daily total[a] (Z/$)
Skilled	1,293.00	18.00	7.24	51.72	24.67	1,394.63	4.75
Unskilled							
1	1,020.00	18.00	5.93	40.80	12.50	1,097.23	3.72
2	1,086.00	18.00	6.25	43.44	12.50	1,166.19	3.95

Data source: ZTA

a Daily cost calculation assumes 295 working days per year.

Formal sector wages for unskilled agricultural workers are substantially higher than the opportunity cost of labor, as evidenced by a 20% unemployment rate outside the communal areas. In addition, there appears to be a high ratio of the unskilled labor wage to average labor productivity in the communal agricultural sector, although no firm estimates of marginal productivity are available (World Bank 1987). Unskilled labor therefore must be shadow priced for the social profitability analysis. Unfortunately, the lack of empirical data on marginal productivity precludes rigorous calculation of an appropriate conversion factor. Based on estimates made by economists in MLARR and at the University of Zimbabwe, an unskilled labor wage rate conversion factor of 0.5 is used in this study for the social profitability analysis.[3]

Skilled labor, on the other hand, is fully utilized in the agricultural sector, so the market rate of Z$ 4.75/day is used in both private and social profitability analysis.

Land--An important policy goal of the government since Independence has been redistribution of agricultural land away from large-scale commercial farmers to small-scale commercial and communal farmers. Although no land has been expropriated from large-scale farmers, the government retains the right to be the first buyer for any land coming onto the market, at a price determined by an independent assessor to reflect "fair market value." This legislation has depressed land prices, discouraged land sales, and effectively precluded consolidation of commercial farms through land purchases.

Largely as a result of that and other legislation pertaining to property ownership and disposal, agricultural land prices in Zimbabwe bear little relation to their apparent value in use. Land leasing is uncommon, and what leasing does occur often involves payment of a token rent (as low as Z$ 5/ha in the Mazowe valley, a prime wheat-growing area), since land owners are generally happy to have a farm worked and maintained rather than idled (Arkell 1987). Rents are higher for land with well-developed irrigation infrastructure and reliable water supplies, but the rental premium in such cases reflects the value of the irrigation rather than the value of the landper se. Consequently, no land rental charges are included in the initial profitability calculations (although the cost of irrigation infrastructure is included separately). The net returns calculated for each cropping enterprise

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3 This conversion factor is conservative. World Bank analysts have recently used a conversion factor of 0.3 (World Bank 1987).

thus represent net returns to the farmer's labor and management, as well as to land.

When resource cost ratios are calculated for the purpose of determining comparative advantage between crops grown on different types of land, an opportunity cost value is assigned to each land type. (Comparative advantage cannot be determined exclusively on the basis of the net returns figures emerging from the crop budgets, because the budget data do not adequately account for differences in land quality.) In theory, the opportunity cost of land planted to a particular crop is simply the net returns to the land in its most profitable alternative use. In practice, applying this straightforward concept is complicated by the fact that there are many different land types with different sets of alternative uses and hence different opportunity cost values. Since assumptions made in opportunity costing land may significantly affect the profitability calculations, it is appropriate to briefly discuss common crop rotation practices on commercial farms in Zimbabwe and the implications for crop substitution.

Cropping patterns on commercial farms in the Highveld and Middleveld are depicted schematically in Figure 6, p. 33. These patterns are influenced by three environmental factors: temperature, rainfall, and soils. Tobacco, maize, soybeans, groundnuts, and some cotton are grown during the warm and humid summer months (roughly October to February), whereas only wheat is grown during the cool, dry winter (roughly May to October). Since rainfall during October and November tends to be scattered and unreliable, typically the summer crops are started off with supplemental irrigation to ensure even germination and proper stand establishment. Wheat, the winter crop, must be grown under full irrigation, using water left over after the needs of the summer crops have been satisfied.

In addition to temperature and rainfall, soils also influence cropping patterns. Tobacco, the most profitable crop, does well only on granite sands ("tobacco soils"), which tend to be fully planted to tobacco. However, tobacco cannot be grown every year because of its heavy nutrient requirements and because continuous cropping causes pest problems to build up; consequently, tobacco generally is grown one year out of four or two years out of five, with the land left to grass fallow in the other years. Several crop rotations are used on the remaining "non-tobacco soils," a catch-all category that actually includes a range of heavier soil types. On the Highveld, maize/soybeans and continuous maize are the most common rotations, followed in popularity by

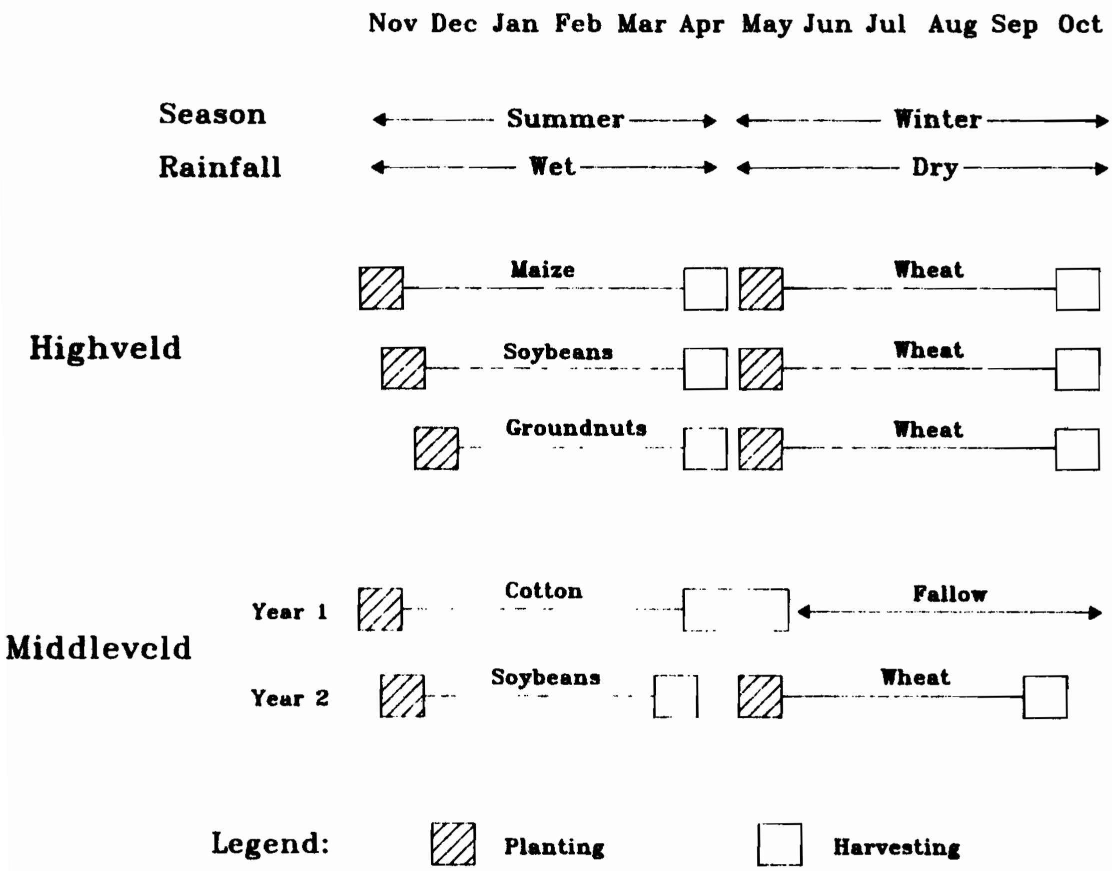

Figure 6. Principal commercial wheat rotations in Zimbabwe.

soybeans/wheat and maize/wheat. Groundnuts/wheat is also practiced in a few areas. In all three of the rotations involving wheat, farmers generally face a time constraint in removing the wheat crop in time to plant the summer crop that follows (although the introduction of short-duration maize and soybean varieties has helped alleviate this problem somewhat). On the Middleveld, the most common rotations include maize/soybeans, maize/wheat, and cotton/fallow/soybeans/wheat over two years. The relatively slow maturation on the Middleveld of the cotton crop generally precludes its being followed in the same year by wheat, although some Middleveld farmers do forego their last cotton picking to put in a late wheat crop.

Since the analysis presented in this paper pertains to typical Highveld and Middleveld wheat farms, no attempt is made explicitly to account for all the possible constraints to substitutability implied by six crops, two growing seasons, and a range of soil types. Instead, three simplifying assumptions are made concerning alternative uses of agricultural land:

1) Irrigated wheat is the only commercially viable winter crop. Although some winter barley is grown under contract to the breweries, the brewery market for barley is very limited, and the feed value of barley is too low to warrant producing barley for feed. Therefore, during winter the next most economic alternative to growing wheat is to leave land idle (its value even as pasture is minimal), and the opportunity cost of land in wheat production is zero.

2) Tobacco, irrigated or rainfed, is by far the most profitable crop, so any land suitable for tobacco production will be used for that purpose. Therefore, the opportunity cost value of land in irrigated tobacco production is considered to be its potential value in rainfed tobacco production, or Z$ 5,137/ha at social prices. (As previously pointed out, however, tobacco cannot be grown every year on the same piece of land. Thus, the long-term profitability of tobacco production is considerably less than the single-cycle budget would imply, since the budget pertains only to the year in which the tobacco is actually grown and ignores the lack of returns during subsequent fallow years. However, since the present analysis is concerned with the allocation of resources among available alternative enterprises, it refers specifically to tobacco soils available for use in the present period, and the full value of the crop is used.)

3) Cotton, soybeans, groundnuts, and maize are all summer crops that can be grown on non-tobacco soils under either irrigated or rainfed regimes. Therefore, the opportunity cost of land in irrigated soybeans, groundnuts, and maize production is considered to be its potential value to the nation in cotton production, or Z$ 1,550/ha, and the opportunity cost of land in cotton production is considered to be its potential value to the nation in the next most profitable use, maize production, or Z$ 679/ha.

Water--In the earlier treatment of irrigation costs (see p. 27), no opportunity cost was assigned to water. Irrigation costs included only the costs of building a dam, installing an irrigation system, and pumping water onto the crop--costs incurred in procuring water, but conceptually distinct from the value of the water itself. This approach is not always adequate for domestic resource cost analysis. During periods of drought, commercial farmers must decide how to allocate limited amounts of water between several alternative cropping enterprises. Water then has an opportunity cost: in choosing to allocate water to a particular crop, the farmer must forego the revenue that might have been generated by allocating it to an alternative crop.

As in the case of land, the opportunity cost of irrigation water in theory is simply the net returns to the water in its most profitable alternative use. In practice, however, net returns to irrigation water depend on many factors, particularly the method of application and its timing in the biological growth cycle of the crop. Consequently, precise calculation of the net returns to irrigation water used in Zimbabwe would require detailed knowledge of the response functions relating the amount and timing of water applied to crop yield. At present, such response functions are not available, although research is underway on this important topic (MacRobert and Mutemeri 1987).

In this study, a simple method has been used to estimate the value of irrigation water applied to the six major commercial crops. The difference in net profitability between growing each crop under irrigated and rainfed regimes is attributed to the effect of the irrigation water. Dividing the increase in net profitability by the amount of water applied gives a measure of incremental net returns per unit of water applied, or the average value of water used on a given crop. (For the sake of simplicity, evaporation losses incurred in storing water from the rainy season into the dry season are ignored.) Depending on whether private or social profitability figures are used, the result represents either the "private value" of water or the "social value" of water applied to each crop.

Capital--An opportunity cost of capital of 10% per annum in real terms was assumed for the profitability analysis. This figure is consistent with the current World Bank estimate, which is based on a number of general considerations: well-balanced capital stock throughout the economy, high capacity utilization rates, well-developed financial markets, real rates of below 10% in the private sector, a real rate of approximately 7% on foreign borrowing for Zimbabwe (Watson 1987).

Enterprise Budgets and Calculation of RCRs

Sources of Data for Enterprise Budgets

Enterprise budgets were constructed for the six most important irrigated crops (wheat, maize, soybeans, groundnuts, cotton, and tobacco) to permit the estimation of private and social profitability and the calculation of resource cost ratios. Budgets were also constructed for five of the six crops grown under rainfed conditions, to provide a standard for comparison between the economics of irrigated and rainfed agriculture.[4] The budgets are representative of commercial farms in the Highveld and Middleveld, where most of Zimbabwe's wheat is grown. (The complete budgets appear in Appendix B. Cropping operations by crop, input use per operation, and total input use per hectare appear in Appendix C.)

Technical coefficients for the budgets were obtained from a number of sources. For all crops except tobacco, the primary sources of technical information were the prototypical budgets published each year by AGRITEX and CFU, which are based on current farm survey data. (Since these two organizations sit on opposite sides of the table during price negotiations, biases in their production cost estimates tend to offset each other.) Tobacco data were obtained from the production files published by the Zimbabwe Tobacco Association (ZTA). All data were verified through interviews with farmers, extension agents, and researchers.

The enterprise budgets reflect recommended levels of input use, which in fact closely resemble levels actually used on commercial farms in the Highveld and Middleveld. The budgets assume that farmers own the machinery required for all crop operations except combine harvesting and aerial application of selected fertilizers and pesticides, which are assumed to be contracted. Machinery costs were obtained from capital budgets estimated for tractors, tillage equipment, combine harvesters, farm dams (with pump), and irrigation equipment (these capital budgets appear in Appendix A).

The enterprise budgets do not take into account non-enterprise-related expenses sometimes included in farm budget analysis as "basic overhead expenses," such as living expenses, accountant's fees, general insurance, and personal taxes. Since these expenses affect all enterprises equally, their exclusion from the present analysis does not affect the ranking of individual crops, although it does increase the apparent profitability of all crops.

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4 No budget was constructed for rainfed wheat, since wheat cannot be grown in the Highveld and Middleveld during the hot summer months when rainfall occurs. Some work is currently underway to develop summer wheats for Zimbabwe, but they are targeted for eventual use in the cooler Eastern Highlands.

Private Profitability

Private profitability per hectare of the six irrigated crops was calculated using 1986 market prices for inputs and outputs. Results of the profitability analysis are shown in Table 13. Tobacco is by far the most profitable irrigated crop from the farmer's point of view, with estimated net returns to land, management, and the farmer's labor of Z$ 2,783/ha. Cotton is the next most profitable irrigated crop, with estimated net returns totalling Z$ 751/ha. Wheat ranks third in estimated private profitability (Z$ 178/ha), followed closely by maize (Z$ 177/ha), groundnuts (Z$ 170/ha), and, finally, soybeans (Z$ 144).

Private profitability per hectare of five of the six crops grown under rainfed conditions also was calculated.[5] Under rainfed conditions, tobacco (Z$ 852/ha) is once again the most profitable crop by far, still followed by cotton (Z$ 259/ha), but maize now ranks third (Z$ 122/ha), followed by soybeans (Z$ 93/ha) and groundnuts (Z$ 82/ha).

Table 13. Estimated private and social profitability of six major crops under irrigated and rainfed production, 1986

	Wheat (Z$/ha)	Maize (Z$/ha)	Soybeans (Z$/ha)	Ground-nuts (Z$/ha)	Cotton (Z$/ha)	Tobacco (Z$/ha)
Private profitability						
Irrigated net returns	178	177	144	170	751	2,783
Rainfed net returns	---	122	93	82	259	852
Social profitability						
Irrigated net returns	682	679	255	385	1,550	8,703
Rainfed net returns	---	315	159	201	637	5,137

Data source: Crop Budgets

5 Rainfed crop budgets were calculated: 1) to determine the alternative use value of tobacco soils used in the production of irrigated tobacco, and 2) to estimate the value of irrigation water.

Social Profitability

Next, the two sets of enterprise budgets (irrigated and rainfed) were recalculated using social prices to assess the relative profitability of the six crops from the point of view of efficiency. As indicated previously, social prices are prices that have been corrected for policy distortions and market failures. Market prices and the corresponding social prices appear in Appendix D, along with a description of how the social prices were derived.

Social profitability was first calculated for the six crops grown under irrigation. In comparison with the results obtained using market prices, two features of the recalculated net returns are noteworthy (Table 13). First, the use of social prices drastically increases the profitability of all six irrigated crops. However, the relative profitabilities remain unchanged; tobacco (Z$ 8,703/ha) is still the most profitable crop, followed by cotton (Z$ 1,550/ha), wheat (Z$ 682/ha), maize (Z$ 679/ha), groundnuts (Z$ 385/ha), and finally soybeans (Z$ 255/ha).

Social profitability was also calculated for the five crops that can be grown under rainfed conditions. As before, the use of social prices increases the profitability of all five rainfed crops without changing the ranking. Tobacco (Z$ 5,137/ha) remains the most valuable, still followed by cotton (Z$ 637/ha), maize (Z$ 315/ha), groundnuts (Z$ 201/ha), and soybeans (Z$ 159/ha).

Comparing Private and Social Profitability

The differences between private profitability and social profitability for each crop grown under irrigation are shown in Table 14, p. 39. These differences represent the net effect per hectare of government policies during 1986 (assuming no price distortions due to market failures). A positive difference implies that government policies on the whole favored production of a particular crop (by making production more profitable to the farmer than it would have been in the absence of policy), whereas a negative difference implies that government policies on the whole discriminated against the production of a particular crop (by making production less profitable to the farmer than it would have been without policy). The results in Table 14 indicate that the net policy effect was negative for all six crops grown under irrigation.

Table 14. Sources of difference between private and social profitability of irrigated crops

Crop	Private profit-ability (Z$/ha)	Social profit-ability (Z$/ha)	Net policy effect (Z$/ha)	Difference due to: Producer price policy (Z$/ha)	Farm machinery prices (Z$/ha)	Purchased input prices (Z$/ha)	Labor policy (Z$/ha)	Credit policy (Z$/ha)	Other policies and market distortions[a] (Z$/ha)
Wheat	178.34	682.31	(503.97)	(329.45)	(41.79)	(91.86)	(38.19)	24.48	(26.16)
Maize	176.89	678.50	(501.61)	(336.00)	(22.14)	(54.81)	(89.16)	20.10	(19.60)
Soybeans	143.69	255.42	(111.73)	0.00	(28.14)	(52.55)	(26.72)	15.22	(19.54)
Groundnuts	169.74	385.36	(215.62)	0.00	(25.93)	(55.96)	(137.87)	24.90	(20.76)
Cotton	751.11	1,549.94	(798.83)	(485.88)	(29.86)	(67.01)	(218.84)	29.33	(26.57)
Tobacco	2,783.37	8,702.70	(5,919.33)	(4,928.19)	(39.41)	(76.94)	(618.50)	86.51	(342.00)

a Includes effects of energy, transport, and insurance policies.

Table 14 disaggregates the net policy effect for each crop to reveal the effects of specific government policies:

1) Producer price policy generally reduced the profitability of commercial agriculture. Farmers received less than the world price equivalent for four out of the six crops (based on 1986 world prices, which were well below long-term trends). The only exceptions were groundnuts and soybeans, the two non-traded crops, whose official producer prices (adjusted for transportation and handling charges) represented undistorted market-clearing prices.

2) Policies affecting farm machinery prices also generally reduced the profitability of agriculture by making farmers pay more to purchase and maintain their machinery than they would have paid in the absence of these policies. However, the taxing effects of import tariffs and sales taxes on farm machinery were partially offset by the overvalued exchange rate, which reduced the prices of farm machinery in local currency.

3) Policies affecting the prices of purchased inputs (seed, fertilizer, crop chemicals) also generally reduced the profitability of agriculture by raising market prices above equivalent world prices. The greatest effect was on nitrogen fertilizer, since continued reliance on high-cost domestic manufacturing capacity resulted in significantly higher costs relative to world nitrogen prices.

4) Labor policy, specifically minimum wage legislation, reduced the profitability of commercial agriculture by increasing the cost of farm labor. This effect was most pronounced for crops requiring high levels of labor input (e.g., tobacco, cotton, groundnuts).

5) Agricultural credit policy, specifically, the provision of AFC credit at rates several points lower than the rates offered by commercial banks, increased the profitability of agricultural production by reducing the cost of short-term credit.

Exchange rate policy is not broken out separately in Table 14, although the effects of the overvalued exchange rate are reflected in the transfers reported for crop prices, farm machinery prices, and purchased inputs prices. Exchange rate policy affects the market prices of tradable inputs and outputs by effectively subsidizing imports (e.g., wheat, farm machinery, purchased inputs) and effectively taxing exports (e.g., maize, soybeans, groundnuts, tobacco, cotton).

Calculating Resource Cost Ratios

Resource cost ratios were calculated for each of the six irrigated crops to provide quantitative measures of comparative advantage. Resource cost ratios measure the efficiency of domestic resource use by indicating the total value of the land, labor, capital, and/or water required to generate or save a unit of foreign exchange.

To calculate resource cost ratios for the six irrigated crops, inputs and outputs were divided into primary factors and tradables. Primary factors (land, labor, capital, and water) were assigned opportunity cost prices. Tradables were assigned social prices--either the world price equivalent (for traded items) or the domestic market price (for non-traded items). These included all outputs, as well as those inputs which were not primary factors, e.g., farm machinery, fuels and oils, electricity, purchased inputs (seed, fertilizers, crop chemicals, packing materials). In addition, 75% of farm machinery repairs and maintenance costs, 50% of transport costs, and 50% of machinery hire charges were also classified as tradable (i.e., spare parts) and were valued at their world price equivalent.

Water was assigned several values, depending on whether or not it was assumed to be the limiting factor in production. Under the normal rainfall scenario, water was assumed to be free, and the only cost was the procurement cost (i.e., irrigation costs). Under the drought scenario, water was assumed to be scarce, and it was assigned a value consisting of the procurement cost plus an opportunity cost, that is, the value of the water in the best alternative use.

The opportunity costs imputed to irrigation water are shown in Table 15, p. 42. As indicated previously, the value imputed to irrigation water was estimated based on the difference in profitability between producing a crop under rainfed conditions and producing the same crop with irrigation. As expected, one unit of water applied to tobacco is associated with a greater increase in private net returns than one unit of water applied to any other crop. Water applied to cotton is associated with the next greatest increase in private net returns, followed by water applied to wheat, maize, soybeans, and groundnuts. These results are consistent with observed practice. In times of drought, farmers in Zimbabwe first allocate limited water supplies to the two high-value crops, tobacco and cotton. Water is applied to grains (maize and wheat) or oilseeds (groundnuts and soybeans) only when the irrigation requirements of tobacco have been satisfied (Pilditch 1987).

Table 15. Average value of irrigation water by crop, 1986

Crop	Amount of irrigation (mm)	Irrigated private net return (Z$/ha)	Rainfed private net return (Z$/ha)	Private net return difference due to irrigation (Z$/ha)	Private value of irrigation (Z$/mm)	Irrigated social net return (Z$/ha)	Rainfed social net return (Z$/ha)	Social net return difference due to irrigation (Z$/ha)	Social value of irrigation (Z$/mm)
Wheat	720.00	178.34	0.00	178.34	0.25	682.31	0.00	682.31	0.95
Maize	240.00	176.89	122.18	54.71	0.23	678.50	315.00	363.42	1.51
Soybeans	240.00	143.69	92.89	50.80	0.21	255.42	159.18	96.24	0.40
Groundnuts	528.00	169.74	82.46	87.28	0.17	385.36	201.25	184.11	0.35
Cotton	624.00	751.11	259.06	492.05	0.79	1,549.94	636.81	913.13	1.46
Tobacco	380.00	2,783.37	851.65	1,931.72	5.08	8,702.70	5,137.21	3,565.49	9.38

Data source: Crop budgets

The social opportunity costs imputed to irrigation water shown in Table 15 differ somewhat from the private opportunity costs. Although water continues to be associated with the greatest increases in social net returns when applied to tobacco, from the point of view of efficiency water has approximately equal value when applied to maize or cotton. Wheat represents the next most profitable use of water, followed by soybeans and groundnuts.

Normal rainfall scenario--Table 16, p. 44, shows the resource cost ratios for the six irrigated crops when water is not the limiting factor of production. This scenario corresponds to years in which rainfall has been abundant and sufficient water is available to irrigate both summer and winter crops. Under the normal rainfall scenario, three irrigated crops--wheat, tobacco, and cotton--have resource cost ratios below one, indicating that Zimbabwe enjoys a comparative advantage in their production.

The resource cost ratio of 0.28 associated with wheat signifies that Z$ 0.28 worth of domestic resources used in wheat production generates Z$ 1.00 of (net) foreign exchange earnings. This extremely low resource cost ratio is largely explained by the fact that land used for irrigated wheat production in the Highveld and Middleveld has no economically viable alternative use in winter and therefore carries an opportunity cost of zero.[6]

Drought scenario--During periods of drought, water becomes a second factor limiting production (in addition to land) in the sense that insufficient water is available to irrigate both summer and winter crops. The question thus arises which crop(s) should be irrigated when water is scarce. The extremely high private and social returns to tobacco production suggest that irrigating tobacco before the other crops will be both profitable for the farmer and efficient from the point of view of the nation. But it is not clear what should be done with the water that remains after all available tobacco soils have been irrigated. Two questions arise: Assuming there is enough water available to irrigate the entire tobacco crop, what crop(s) should next be irrigated? In the event of a drought, is profit-maximizing behavior on the part of farmers consistent with efficient allocation of resources?

Table 17, p. 45, shows the resource cost ratios for the six irrigated crops during times of drought, when water is a limiting factor of production. Under the drought scenario, irrigating one crop means not being able to irrigate other crops, so an opportunity cost is assigned to water equal to its highest

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6 This extremely low resource cost ratio suggests that Zimbabwe's comparative advantage in wheat production would not be threatened even if land planted to winter wheat had some alternative use value (opportunity cost).

Table 16. Resource cost ratios, normal rainfall scenario

	Wheat (Z$/ha)	Maize (Z$/ha)	Soybeans (Z$/ha)	Groundnuts (Z$/ha)	Cotton (Z$/ha)	Tobacco (Z$/ha)
Tradables						
A) Outputs						
Value of production	1,979.45	1,886.00	1,020.00	1,627.50	2,923.38	12,428.18
B) Inputs						
Machinery depreciation	212.19	140.75	97.34	181.14	188.13	191.71
0.75 * Repairs and maintenance	52.69	63.08	34.86	55.24	48.42	127.18
Fuels and oils	42.69	62.00	32.38	48.73	39.88	112.75
Purchased inputs	394.48	316.47	267.43	548.85	405.88	796.97
0.5 * Transport	44.01	60.41	26.47	51.95	34.03	195.05
0.5 * Machinery hire charges	37.32	6.83	37.38	0.00	67.95	27.50
Packing materials	10.89	8.93	2.50	8.59	7.75	38.00
Electricity	244.80	81.60	81.60	179.52	212.16	129.20
Miscellaneous						
Drying	2.98		2.95			239.50
Insurance	6.93	9.61	3.50	7.73	11.69	364.00
Levies	9.90	11.80	13.12	28.99	40.93	167.00
Domestic resources						
Capital	89.58	72.69	55.09	102.52	109.09	278.32
Labor	45.77	98.73	31.73	145.39	225.30	630.33
0.25 * Repairs and maintenance	17.56	21.03	11.62	18.41	16.14	42.39
0.5 * Transport	44.01	60.41	26.45	51.95	34.03	195.05
0.5 * Machinery hire charges	37.32	6.83	37.38	0.00	67.95	27.50
Land[a]	0.00	1,549.94	1,549.94	1,549.94	678.50	5,137.21
Water	0.00	0.00	0.00	0.00	0.00	0.00
Net cost--domestic resources	234.24	1,809.63	1,712.21	1,868.21	1,131.01	6,310.80
Value added--tradables	847.38	852.93	347.04	460.48	1,826.18	10,716.83
Resource cost ratio	0.28	2.12	4.93	4.06	0.62	0.59

a Residual returns to land in best competing alternative valued at world price equivalent. Alternatives assumed as follows: wheat vs. fallow; tobacco vs. rainfed tobacco; maize vs. soybeans vs. cotton vs. groundnuts. Residual returns (Z$/ha) = wheat, 682.31; maize, 678.50; soybeans, 255.42; groundnuts, 385.36; cotton, 1,549.94; tobacco, 8,702.70; and rainfed tobacco, 5,137.21.

Table 17. Resource cost ratios, drought scenario

	Wheat (Z$/ha)	Maize (Z$/ha)	Soybeans (Z$/ha)	Groundnuts (Z$/ha)	Cotton (Z$/ha)	Tobacco (Z$/ha)
Tradables						
A) Outputs						
Value of production	1,979.45	1,886.00	1,020.00	1,627.50	2,923.38	12,428.18
B) Inputs						
Machinery depreciation	212.19	140.75	97.34	181.14	188.13	191.71
0.75 * Repairs and maintenance	52.69	63.08	34.86	55.24	48.42	127.18
Fuels and oils	42.69	62.00	32.38	48.73	39.88	112.75
Purchased inputs	394.48	316.47	267.43	548.85	405.88	796.97
0.5 * Transport	44.01	60.41	26.47	51.95	34.03	195.05
0.5 * Machinery hire charges	37.32	6.83	37.38	0.00	67.95	27.50
Packing materials	10.89	8.93	2.50	8.59	7.75	38.00
Electricity	244.80	81.60	81.60	179.52	212.16	129.20
Miscellaneous						
Drying	2.98		2.95			239.50
Insurance	6.93	9.61	3.50	7.73	11.69	364.00
Levies	9.90	11.80	13.12	28.99	40.93	167.00
Domestic resources						
Capital	89.58	72.69	55.09	102.52	109.09	278.32
Labor	45.77	98.73	31.73	145.39	225.30	630.33
0.25 * Repairs and maintenance	17.56	21.03	11.62	18.41	16.14	42.39
0.5 * Transport	44.01	60.41	26.45	51.95	34.03	195.05
0.5 * Machinery hire charges	37.32	6.83	37.38	0.00	67.95	27.50
Land[a]	0.00	0.00	0.00	0.00	0.00	0.00
Water[b]	1,087.20	350.40	362.40	797.28	942.24	573.80
Net cost--domestic resources	1,321.44	610.09	524.67	1,115.55	1,394.75	1,747.39
Value added--tradables	847.38	852.93	347.04	460.48	1,826.18	10,716.83
Resource cost ratio	1.56	0.72	1.51	2.42	0.76	0.16

a Land costs are not included separately because they are implicitly included in water costs (water costs calculated based on net returns to management and land).

b Residual returns to water (and land) in best competing alternative valued in social prices as follows (Z$/mm): on wheat, 0.95; on maize, 1.51; on soybeans, 0.40; on groundnuts, 0.35; on cotton, 1.46; and on tobacco, 9.38.

alternative use value. Initially the most efficient course of action is to irrigate tobacco, which shows an extremely low resource cost ratio of 0.16. But assuming that not all land is suitable for tobacco production, eventually land becomes a limiting factor as well. If water is left over after all available tobacco soils have been planted to tobacco, the opportunity cost of the remaining water is no longer its value in tobacco production, since the land constraint precludes planting more tobacco. Once all available tobacco soils have been planted, the opportunity cost for water reverts to its value in the most profitable remaining possible use, maize production (except in the case of maize production itself, where the most profitable alternative use is cotton production).

As can be seen in Table 17, when these lower opportunity costs for water are used, the resource cost ratios associated with maize (0.72) and cotton (0.76) both drop below one. These results indicate that in times of drought, once the tobacco crop has been irrigated, Zimbabwe has a comparative advantage in maize and cotton production. The resource cost ratio associated with wheat remains above one (1.56), indicating that wheat production does not represent an efficient use of domestic resources when water supplies are limited, even after the tobacco crop has been irrigated.

Policy Implications

Effects of Current Policies

One important implication of the preceding analysis is that existing agricultural policies in Zimbabwe provide disincentives for commercial farmers, because private profitability is less than social profitability for all six crops. In other words, government policies are taxing away a large portion of the social profits (assuming no effects due to market failures). However, this tax occurs across all commodities with similar incidence, so that the private incentives among crops are not greatly distorted from their social pattern. Thus, although they reduce the overall private profitability of farming, current policies at least encourage commercial farmers to plant those crops in which Zimbabwe currently has a comparative advantage.

The budgets calculated for irrigated wheat, maize, soybeans, groundnuts, cotton, and tobacco confirm what many farmers already know: although all six crops generate positive net returns, given current market prices it is most profitable for farmers to concentrate first on tobacco and second on cotton. The resource cost ratios calculated using social prices reveal that what is good for farmers frequently is also good for the nation: Zimbabwe enjoys a comparative advantage in these two crops, at least during years when water is plentiful. However, the resource cost ratios indicate that if water availability is limited by drought, once tobacco irrigation needs have been satisfied there is a slight efficiency gain in using the remaining water to apply supplementary irrigation to maize.

Several interesting policy effects become evident through the use of social prices:

1) Producer price policy in Zimbabwe discriminates against all six of the crops examined in this study. Producers receive significantly less for their crops than the equivalent world price. Thus, producer price policy effectively taxes commercial agriculture.

2) A number of government policies affect the prices paid by farmers for their machinery and purchased inputs. Taxes (e.g., import tariffs and sales taxes) exert upward pressure on prices, but this effect is partially offset by exchange rate policy, since the overvaluation of the Zimbabwe dollar effectively reduces the domestic price of imported machinery and inputs. In addition, the rationing of foreign exchange restricts the availability of imported inputs, implying an additional cost to producers (presumably reflected in higher marketing margins earned by distributors).

3) Labor policies have a differential impact across crops. During the last five years, minimum wage legislation has succeeded in raising the incomes of agricultural workers employed in the formal wage sector. However, higher incomes have been achieved at the cost of fewer jobs. Minimum wage legislation has raised the cost of agricultural labor, inducing employers to substitute capital for labor by hiring fewer workers and purchasing additional machinery to perform a wider range of crop operations. In cases where mechanization is infeasible (e.g., harvesting tobacco and cotton), production costs are driven up.

4) Wheat can be a profitable crop for farmers in the Middleveld and Highveld of Zimbabwe, although it is certainly less profitable than some of the summer crops. Significantly, as long as irrigation water is readily available, wheat production is also efficient. But in times of drought, when farmers must choose between irrigating wheat and irrigating other crops, it is more profitable for farmers and more efficient in terms of domestic resources to use water on tobacco, maize, and cotton.

Effects of Possible Future Developments

Technological change--In looking to the future, policymakers in Zimbabwe must keep in mind that the present pattern of comparative advantage is not static. Although heavily influenced by parameters that must be considered fixed in the short run, such as primary factor endowments and technology, Zimbabwe's comparative advantage is likely to change over time as these parameters change. Some of the parameters will be difficult for policymakers to influence, but others--especially technology--may be subject to deliberate manipulation. Policymakers in all likelihood will be able to take an active role in shaping Zimbabwe's future pattern of comparative advantage by influencing the direction and nature of technological change.

Zimbabwe presently enjoys a comparative advantage in wheat production during periods when irrigation water is plentiful, but this comparative advantage is lost during times of drought when water becomes a limiting factor of production. By implication, the introduction of more water-efficient wheat production technologies might allow the comparative advantage in wheat production to be maintained even in periods when water is scarce. Break-even analysis suggests that Zimbabwe's comparative advantage in wheat production would be maintained even during periods of drought if the crop's irrigation requirement could be reduced from the present 720 mm (gross) to around 410 mm (gross).

Zimbabwe's future self-sufficiency level in wheat thus could depend critically on near-term investments in research designed to increase the efficiency of water use by the crop. Water use efficiency could be improved through the development of more drought-resistant germplasm, through development of more efficient irrigation management methods, or through some combination of the two. Although irrigation scheduling for wheat is presently not receiving much attention within public research institutions, efforts are underway in the private sector to develop improved irrigation scheduling methods allowing for substantial reductions in the crop's overall irrigation requirements. Preliminary results indicate that yields of wheat can be maintained in spite of significant reductions in input use levels, suggesting that technological change has the potential to increase Zimbabwe's comparative advantage in wheat production in the short- or medium-run.

Changes in input and output prices--Comparative advantage is determined not only by technology, but also by the prices of inputs and outputs. One nice feature of the DRC framework is that it can be used to calculate how future price changes are likely to affect comparative advantage. Despite the difficulty of forecasting future developments in world commodity markets, recalculation of the enterprise budgets using "bestguess" estimates of future inputs and outputs prices allows policymakers to determine whether or not the results of the comparative advantage analysis are highly sensitive to price changes.

Table 18. Profitability of irrigated crops at projected prices compared to profitability at current prices

Irrigated crop	Social net returns to land and management at 1986 prices[a] (Z$/ha)	Social net returns to land and management at 2000 prices[a] (Z$/ha)
Wheat	682	1,006
Maize	679	778
Soybeans	255	490
Groundnuts	385	771
Cotton	1,550	4,663
Tobacco	8,703	9,169

Data source: Crop budgets
a Assumes water is not a limiting factor of production.

The profitability of the six irrigated crops was recalculated using projected future prices for outputs and fertilizers. Table 18 shows net returns to land and management at current (1986) prices compared to net returns at projected (2000) prices. The year 2000 prices were estimated by adjusting current prices upward or downward by the percentage changes forecast by World Bank commodity price analysts. These percentage changes are obtained by making trend projections and then adjusting them to reflect the likely effects of expected structural changes in supply and demand, as well as expected changes in the policies of major exporting and importing countries (World Bank 1986). During the next twelve years, the World Bank projections foresee stronger prices for flue-cured tobacco based on continuing demand for lighter leaf, a gradual firming of cotton prices once current surpluses are eliminated, an eventual return of grain prices to long-term downward trends following short-term increases as exporting countries make much-needed policy adjustments, and a slight rise in oilseed prices. Prices of the three main fertilizers imported by Zimbabwe (urea, muriate of potash, and triple super phosphate) all are projected to rise modestly.

When the projected year 2000 prices are substituted for current prices in the budgets, the estimated social profitability of the six crops shows little change.

Tobacco (Z$ 9,169/ha) remains the most profitable crop by far, followed by cotton (Z$ 4,663/ha), wheat (Z$ 1,006/ha), maize (Z$ 778/ha), groundnuts (Z$ 771/ha), and soybeans (Z$ 490/ha).

These figures suggest that future developments in global commodities markets probably will not eliminate Zimbabwe's current comparative advantage in tobacco and cotton production. Although this conclusion must be tempered by the knowledge that past forecasts of world commodity prices have often been inaccurate, the fact that tobacco is nearly ten times as profitable as the highest-ranking grain, and cotton nearly five times as profitable, suggests that relative prices would have to change a great deal for these two traditional export crops to be displaced.

On the other hand, internal developments within the Zimbabwean economy could have an effect on comparative advantage. Given the high transport costs associated with moving commodities in and out of Zimbabwe, the gap between import and export parity prices is extremely wide. Consequently, if Zimbabwe goes from being a net importer to a net exporter of a particular crop, or vice versa, the world price equivalent (i.e., the measure of the value of the crop to the nation) changes considerably, with potentially significant effects for the calculation of social profitability and resource cost ratios. Although Zimbabwe is almost certain to remain a net exporter of tobacco and cotton, the situation regarding grains and oilseeds is less certain. At present, Zimbabwe is fairly close to self-sufficiency in the production of most grains and oilseeds. Depending on the future evolution of domestic demand and the structure of producer incentives, the nation could conceivably end up importing or exporting wheat, maize, soybeans, and/or groundnuts. Even though Zimbabwe is unlikely to become competitive for some of these crops in global markets, important trading opportunities could conceivably develop in regional markets.

Restrictions on agricultural trade--Political developments in South Africa, to the extent that they have economic consequences, also could affect Zimbabwe's current structure of comparative advantage, with important implications for food policy. In particular, further restrictions on trade with and transit through South Africa would have considerable effects on the agricultural sector by affecting the availability and prices of production inputs, the prices received for agricultural exports, and the prices paid for food imports.

It is difficult to model the effects of such a scenario with any degree of quantitative precision, since it is impossible to predict what form trade restrictions might take. Nevertheless, the effects of a restricted-trade scenario can be anticipated in qualitative terms. In general, production costs for all crops would increase because imported inputs would become more expensive. At the same time, the value of export commodities would decline due to the increased cost of getting them to market, while the value of import-competing commodities would rise due to the increased cost of procuring supplies from outside the country. As increases in transportation costs widen the spread between CIF and FOB prices, more and more tradables would be expected to become non-traded.

These quantitative conclusions concerning the likely effects of trade restrictions are borne out by sensitivity analysis of the irrigated crop budgets. Table 19 shows the estimated social profitabilities of the six irrigated crops under a "restricted trade" scenario. One likely impact of trade restrictions has been modelled by increasing port-to-border rail freight rates for all crops, as well as for imported fertilizers, by a factor of 3. As expected, the social profitability of (import-competing) wheat increases relative to that of the export crops.

Table 19. Estimated social profitability of irrigated crops under a "restricted-trade" scenario

Irrigated crop	Social net returns to land and management (free trade) (Z$/ha)	Social net returns to land and management (restricted trade)[a] (Z$/ha)
Wheat	682	1,375
Maize	679	35
Soybeans	113	(260)
Groundnuts	684	395
Cotton	1,550	964
Tobacco	8,703	8,200

Data source: Crop budgets
a Railage and handling charges to port increased *3

Trade restrictions thus would have at least two implications for agricultural policy. First, since the social value of wheat would rise as a function of rising import costs, it would probably make economic sense for Zimbabwe to strive for higher levels of self-sufficiency in wheat, presumably through some combination of production-enhancement and consumption-management policies. (One obvious way to decrease demand would be to pass along to consumers the increase in the price of imported wheat caused by an increase in the CIF-FOB margin.) If the trade restrictions also affect other SADCC countries, it is possible that Zimbabwe would additionally be able to export wheat to some of its neighbors, assuming export supplies were available.

Second, producer policies relating to crops other than wheat would depend on the relationship between domestic production and consumption levels. As long as Zimbabwe remained a net importer of a crop, its social price (import parity price) would be increased by trade restrictions. But if production exceeded domestic demand, the value of additional (surplus) production would fall considerably due to the high cost of exporting. Under a restricted-trade scenario, tobacco and probably cotton would remain profitable export crops for some time, depending on the degree to which export costs were affected. However, soybeans and groundnuts would remain non-competitive in the global market, and maize would probably soon become non-competitive as well. Trade in these three crops would be uneconomic, although limited opportunities might arise for exporting to neighboring countries.

Conclusion

Agricultural policymakers in Zimbabwe today face the difficult question of what to do about the widening gap between supply and demand of wheat. Even though Zimbabwe's wheat industry is well developed by regional standards, the fact that domestic production has not kept pace with demand has made imports necessary, draining scarce foreign exchange and heightening concerns about national food security. The question of whether or not wheat production should be expanded thus assumes critical importance in the food policy debate.

This study was undertaken to establish whether or not Zimbabwe enjoys a comparative advantage in wheat production and to assess the effects of government policies on producer incentives. Using 1986 data, comparative advantage was measured by calculating resource cost ratios for six major commercial crops under a normal rainfall scenario and under a drought scenario in order to determine which crops represent the most efficient use of domestic resources.

The results presented above suggest that policies in Zimbabwe tax all principal commercial crops significantly, but provide no discriminating disincentives to dissuade commercial farmers from allocating scarce resources to efficient crops (tobacco and cotton, in most instances). The results also reveal how government policies affect the economics of farming, rarely positively (e.g., subsidized agricultural credit programs), and mostly negatively (e.g., controlled producer prices, taxes on inputs, wage policies).

Wheat production represents an efficient use of Zimbabwe's resources when water is plentiful. This implies that the government should be careful to set wheat producer prices at least high enough to enable farmers to recover variable costs, thereby ensuring continued production during the winter season. However, during times of drought both farmers and the nation as a whole are better off if water is used to irrigate tobacco, then cotton and maize. This implies that the government might consider relaxing its current policy of requiring NFIF-loan farmers to grow wheat during the winter months, if it means they will not have enough water to irrigate tobacco in the following season.

Water is more valuable when used on crops other than wheat partly because many farmers apply water inefficiently to wheat. Since farmers in Zimbabwe have not benefited from a long history of growing wheat under drought conditions, many still schedule wheat irrigations according to unrefined "rules of thumb." A growing body of evidence, including farmer experience, suggests that total amounts of water applied to wheat can be reduced significantly below current levels without drastically affecting yields. Research is currently underway on this critical issue, but much additional work remains to be done in determining wheat yield response to water applications. Once this response is worked out and more efficient irrigation scheduling methods devised, the value of water applied to wheat may rise to the point of becoming comparable with the value of water applied to other crops. Eventually, given sufficient reductions in the crop's irrigation requirements, Zimbabwe might retain its comparative advantage in wheat production even during periods of extreme drought.

Sensitivity analysis was used to test the robustness of the results under several possible future scenarios. Use of projected year 2000 prices for outputs and major inputs did not significantly alter the comparative advantage rankings. However, use of high rail freight costs for imports and exports to simulate the likely effects of trade restrictions increased the profitability of wheat production relative to that of other crops; a shift in production patterns would be appropriate if access to international markets via South Africa were to become restricted.

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Appendices

Appendix A
Capital Budgets for Machinery and Irrigation Investments

Table A1. Capital budgets for machinery and irrigation investments, 1988

	Tractor	Tillage equipment	Combine	Dam and pump	Irrigation equipment
Fixed costs					
Horsepower	65.00		120.00		
Purchase price (Z$) (1)	45,000.00	7,500.00	150,000.00	2,500.00	2,500.00
Salvage value coefficient	0.05	0.05	0.05	0.05	0.05
Salvage value	2,250.00	375.00	7,500.00	125.00	125.00
Hours of use per year (2)	585.00	585.00	500.00	2,000.00	2,000.00
Years of life	12.00	15.00	12.00	20.00	20.00
Annual depreciation charge	3,562.50	475.00	11,875.00	118.75	118.75
Hourly depreciation charge	6.09	0.81	23.75	0.06	0.06
Real interest rate	0.10	0.10	0.10	0.10	0.10
Average annual cost of capital	2,137.50	356.25	7,125.00	118.75	118.75
Average hourly cost of capital	3.65	0.61	14.25	0.06	0.06
Variable costs					
Repairs cost coefficient	1.00	0.10	1.00	0.25	0.25
Average annual repairs cost	3,562.50	47.50	11,875.00	29.69	29.69
Average hourly repairs cost	6.09	0.08	23.75	0.01	0.01
Hourly fuel consumption (l) (2,3)	7.00		16.20		
Average price of fuel ($Z/l)	0.60		0.60		
Hourly cost of fuel	4.20		9.73		
Annual oils consumption (l) (2,4)	67.66		125.00		
Hourly oils consumption (l)	0.12		0.25		
Average price of oils (Z$/l)	2.34		2.34		
Hourly cost of oils	0.27		0.59		
Annual insurance and license (3)	50.11		1,027.17		
Hourly insurance and license	0.09		2.05		
1988 Machinery operating costs, exclusive of operator's labor (Z$/hr)					
Depreciation	6.09	0.81	23.75	0.06	0.06
Cost of capital	3.65	0.61	14.25	0.06	0.06
Maintenance and repairs	6.09	0.08	23.75	0.01	0.01
Fuel	4.20	0.00	9.73		
Oils (engine and gear)	0.27	0.00	0.59		
Insurance and license	0.09	0.00	2.05		
Total	20.39	1.50	74.12	0.13	0.13

Data sources: (1) Farm machinery dealer, Harare; (2) Commercial Farmers Union; (3) Agricultural Research Trust Farm; and (4) CIMMYT engineer's estimate.

a Electricity costs for irrigation included separately in crop budgets at the rate of Z$ 34/1,000 m3.

Appendix B
Enterprise Budgets

Table B1. Irrigated crop budgets, market prices, 1986

	Irrigated wheat	Irrigated maize	Irrigated soybeans	Irrigated groundnuts	Irrigated cotton	Irrigated tobacco
Assumed yield (t/ha)	5.50	7.50	3.00	3.50	3.25	3.00
	(Z$/ha)	(Z$/ha)	(Z$/ha)	(Z$/ha)	(Z$/ha)	(Z$/ha)
Gross returns	1,650.00	1,350.00	1,020.00	1,627.50	2,437.50	7,500.00
Fixed costs						
Irrigation costs						
Dam and pump	85.50	28.50	28.50	62.70	74.10	45.13
Irrigation equipment	85.50	28.50	28.50	62.70	74.10	45.13
Farm machinery costs						
Tractor depreciation	67.60	98.17	51.28	77.16	63.15	121.79
Tillage equipment depreciation	9.01	13.09	6.84	10.29	8.42	16.24
Tobacco barns and sheds						163.00
Variable costs						
Machinery operation costs						
Tractor fuel	46.65	67.75	35.39	53.25	43.58	123.00
Tractor oils	3.12	4.53	2.36	3.56	2.91	
Tractor repair and maintenance	67.60	98.17	51.28	77.16	63.15	200.00
Tillage equipment repair and maintenance	0.90	1.31	0.68	1.03	0.84	
Purchased inputs						
Seed (and treatment)	72.00	35.75	71.75	111.25	15.72	5.00
Fertilizer and lime	399.77	275.31	165.55	174.06	231.25	390.91
Herbicides	13.52	46.93	72.62	111.44	57.90	478.00
Pesticides	5.05	13.29	10.07	22.33	168.02	
Fungicides				185.22		
Packing materials	10.89	8.93	2.50	8.59	7.75	38.00
Irrigation costs						
Electricity	244.80	81.60	81.60	179.52	212.16	129.20
Repairs and maintenance	21.38	7.13	7.13	15.67	18.53	11.28
Contract hire services						
Aerial pesticide application					135.90	55.00
Aerial fertilizer application		13.65				
Combine harvesting	89.17		89.30			
Transport, farm to depot	46.75	77.63	31.05	63.00	39.46	355.00
Other costs						
Fertilizer transport/handling	20.96	15.31	9.67	16.93	12.90	
Crop insurance	5.78	7.70	4.08	6.51	9.75	364.00
Drying	2.98		2.95			479.00
Levy	8.25	9.45	15.30	24.41	34.13	167.00
Labor costs						
Skilled labor	6.59	9.57	5.00	7.52	6.16	11.88
Unskilled labor	78.37	178.32	53.45	275.74	438.28	1,237.00
Interest on working capital (6 mo.)	79.54	66.19	49.47	92.94	104.14	281.08
Total fixed costs	247.61	168.26	115.11	212.84	219.77	391.28
Total variable costs	1,224.06	1,004.85	761.19	1,244.91	1,466.62	4,325.34
Total costs	1,471.66	1,173.11	876.31	1,457.76	1,686.39	4,716.63
Net returns to management, land	178.34	176.89	143.69	169.74	751.11	2,783.37

Table B2. Irrigated crop budgets, social prices, 1986

	Irrigated wheat	Irrigated maize	Irrigated soybeans	Irrigated groundnuts	Irrigated cotton	Irrigated tobacco
Assumed yield (t/ha)	5.50	7.50	3.00	3.50	3.25	3.00
	(Z$/ha)	(Z$/ha)	(Z$/ha)	(Z$/ha)	(Z$/ha)	(Z$/ha)
Gross returns	1,979.45	1,686.00	1,020.00	1,627.50	2,923.38	12,428.19
Fixed costs						
Irrigation costs						
Dam and pump	74.81	24.94	24.94	54.86	64.84	39.48
Irrigation equipment	74.81	24.94	24.94	54.86	64.84	39.48
Farm machinery costs						
Tractor depreciation	56.73	82.39	43.03	64.76	53.00	102.22
Tillage equipment depreciation	5.84	8.48	4.43	6.66	5.45	10.52
Tobacco barns and sheds						163.00
Variable costs						
Machinery operation costs						
Tractor fuel	39.73	57.70	30.14	45.35	37.12	112.75
Tractor oils	2.96	4.30	2.25	3.38	2.77	
Tractor repair and maintenance	53.51	77.72	40.59	61.08	49.99	161.11
Tillage equipment repair and maintenance	0.71	1.04	0.54	0.81	0.67	
Purchased inputs						
Seed (and treatment)	72.00	35.75	71.75	111.25	15.72	5.00
Fertilizer and lime	308.38	222.00	115.07	126.08	169.89	266.17
Herbicides	13.18	45.76	70.80	108.66	56.46	525.80
Pesticides	4.93	12.96	9.82	21.77	163.81	
Fungicides				180.59		
Packing materials	10.89	8.93	2.50	8.59	7.75	38.00
Irrigation costs						
Electricity	244.80	81.60	179.52	212.16	129.20	
Repairs and maintenance	16.03	5.34	5.34	11.76	13.89	8.46
Contract hire services						
Aerial pesticide application					135.90	55.00
Aerial fertilizer application		13.65				
Combine harvesting	74.64		74.76			
Transport, farm to depot	60.78	100.91	40.37	81.90	51.29	390.10
Other costs						
Fertilizer transport/handling	27.24	19.91	12.57	22.00	16.76	
Crop insurance	6.93	9.61	4.08	6.51	11.69	364.00
Drying	2.98		2.95			239.50
Levy	9.90	11.80	15.30	24.41	40.93	167.00
Labor costs						
Skilled labor	6.59	9.57	5.00	7.52	6.16	11.88
Unskilled labor	39.18	89.16	26.73	137.87	219.14	618.50
Interest on working capital (6 mo.)	89.58	72.69	55.09	102.52	109.09	278.32
Total fixed costs	212.19	140.74	97.34	181.14	188.13	354.71
Total variable costs	1,084.94	866.75	667.24	1,060.99	1,185.30	3,370.79
Total costs	1,297.14	1,007.50	764.58	1,242.14	1,373.43	3,725.49
Net returns to management, land	682.31	678.50	255.42	385.36	1,549.94	8,702.70

Table B3. Rainfed crop budgets, market prices, 1986

	Rainfed maize	Rainfed soybeans	Rainfed groundnuts	Rainfed cotton	Rainfed tobacco
Assumed yield (t/ha)	4.50	2.00	2.00	1.50	2.00
	(Z$/ha)	(Z$/ha)	(Z$/ha)	(Z$/ha)	(Z$/ha)
Gross returns	810.00	680.00	930.00	1,125.00	5,000.00
Fixed costs					
Farm machinery costs					
Tractor depreciation	79.90	51.28	77.18	63.15	121.79
Tillage equipment depreciation	10.65	6.84	10.29	8.42	16.24
Tobacco barns and sheds					163.00
Variable costs					
Machinery operation costs					
Tractor fuel	55.14	35.39	53.25	43.58	123.00
Tractor oils	3.68	2.36	3.56	2.91	
Tractor repair and maintenance	79.90	51.28	77.16	63.15	200.00
Tillage equipment repair and maintenance	1.07	0.68	1.03	0.84	
Purchased inputs					
Seed (and treatment)	35.75	71.75	111.25	15.72	5.00
Fertilizer and lime	137.66	82.78	87.03	115.63	195.46
Herbicides	46.93	72.62	111.44	57.90	478.00
Pesticides	13.29	10.07	22.33	168.02	
Fungicides			185.22		
Packing materials	8.93	2.50	8.59	4.13	38.00
Contract hire services					
Aerial pesticide application				135.90	55.00
Aerial fertilizer application	13.65				
Combine harvesting		89.30			
Transport, farm to depot	46.58	20.70	36.00	18.21	355.00
Other costs					
Fertilizer transport/handling	7.66	4.84	8.46	6.45	
Crop insurance	4.62	2.72	3.72	4.50	364.00
Drying		1.97			479.00
Levy	5.67	10.20	13.95	15.75	167.00
Labor costs					
Skilled labor	7.79	5.00	7.52	6.16	11.88
Unskilled labor	102.92	30.47	153.37	210.97	1,091.00
Interest on working capital (6 mo.)	39.70	34.38	61.43	60.45	284.99
Total fixed costs	90.55	58.11	87.44	71.57	301.03
Total variable costs	597.27	529.00	760.10	794.37	3,847.32
Total costs	687.82	587.11	847.54	865.94	4,148.35
Net returns to management, land	122.18	92.89	82.46	259.08	851.65

Table B4. Rainfed crop budgets, social prices, 1986

	Rainfed maize	Rainfed soybeans	Rainfed groundnuts	Rainfed cotton	Rainfed tobacco
Assumed yield (t/ha)	4.00	2.00	2.00	1.50	2.00
	(Z$/ha)	(Z$/ha)	(Z$/ha)	(Z$/ha)	(Z$/ha)
Gross returns	899.20	680.00	930.00	1,349.25	8,285.46
Fixed costs					
Farm machinery costs					
Tractor depreciation	67.06	43.03	64.76	53.00	102.22
Tillage equipment depreciation	6.90	4.43	6.66	5.45	10.52
Tobacco barns and sheds					163.00
Variable costs					
Machinery operation costs					
Tractor fuel	46.96	30.14	45.35	37.12	112.75
Tractor oils	3.50	2.25	3.38	2.77	
Tractor repair and maintenance	63.25	40.59	61.08	49.99	161.11
Tillage equipment repair and maintenance	0.84	0.54	0.81	0.67	
Purchased inputs					
Seed (and treatment)	35.75	71.75	111.25	15.72	5.00
Fertilizer and lime	114.52	62.80	67.56	90.11	141.62
Herbicides	45.76	70.80	108.66	56.46	525.80
Pesticides	12.96	9.82	21.77	163.81	
Fungicides			180.59		
Packing materials	8.93	2.50	8.59	4.13	38.00
Contract hire services					
Aerial pesticide application				135.90	55.00
Aerial fertilizer application	13.65				
Combine harvesting		74.76			
Transport, farm to depot	53.82	26.91	46.80	23.67	292.58
Other costs					
Fertilizer transport/handling	9.95	6.29	11.00	8.38	
Crop insurance	5.13	2.72	3.72	5.40	364.00
Drying		1.97			239.50
Levy	6.29	10.20	13.95	18.89	167.00
Labor costs					
Skilled labor	7.79	5.00	7.52	6.16	11.88
Unskilled labor	51.46	15.24	76.69	105.49	545.50
Interest on working capital (6 mo.)	43.25	39.08	69.19	65.22	212.78
Total fixed costs	73.96	47.46	71.42	58.45	275.74
Total variable costs	510.16	473.35	657.33	653.98	2,872.51
Total costs	584.12	520.82	728.75	712.44	3,148.25
Net returns to management, land	315.08	159.18	201.25	636.81	5,137.21

Appendix C

Table C1. Cropping operations used in enterprise budgets

	Irrigated wheat	Irrigated maize	Irrigated soybeans	Irrigated groundnuts	Irrigated cotton
Yield (t/ha)	5.50	7.00	3.00	3.50	3.25
	Number of Operations				
Apply lime	0.25	0.25	1.00	1.00	1.00
Rome					0.67
Rip			1.00		0.67
Plow	1.00	1.00	0.33	1.00	0.33
Disc	1.00	1.00	1.00		0.33
Harrow				1.00	
Land plane	1.00		0.33		0.33
Basal fertilizer	1.00				
Incorporate fertilizer	1.00				
Disc in herbicide					1.00
Drill seed/fertilizer		1.00	1.00	1.00	1.00
Broadcast seed	1.00				
Harrow to cover seed	1.00				
Roll	1.00				
Thin				1.00	
Hand weed			1.00	2.00	2.00
Tine weed (mechanical)			1.00	1.00	1.00
Top dress fert. VC	1.00	1.00		1.00	1.00
Top dress fert. Air		1.00			
Irrigate: hand line	14.40	4.80	4.80	10.56	12.48
Spray herbicide	1.00	1.00	1.00	2.00	1.00
Spray insecticide	1.00	2.00	1.00	7.00	
Aerial spray insecticide					10.00
Guard crop		1.00			
Combine harvest	1.00		1.00		
Hand pick maize		1.00			
Hand pick cotton					1.00
Hand pick groundnuts				1.00	
On-farm transport	1.00	1.00	1.00	1.00	1.00
Dry crop	1.00		1.00	1.00	
Shell maize		1.00			
Bale cotton					1.00
Bag crop	1.00	1.00	1.00	1.00	
Transport to depot	1.00	1.00	1.00	1.00	1.00
Slash/burn crop residue					1.00
Commute	1.00	1.00	1.00	1.00	1.00

Data sources: Wheat (AGRITEX, Winter 1986); maize, soybeans, groundnuts, and cotton (AGRITEX 1986-87).

Note: Tobacco budgets constructed from ZTA data; no information available on cropping operations.

Table C2. Input use per hectare per operation

	Skilled labor (hr/ha)	Unskilled labor (hr/ha)	Tractor (hr/ha)	Tillage equipment (hr/ha)	Irrigation equipment (hr/ha)
Apply lime (broadcast)	0.33	0.33	0.33	0.33	
Rome (3m)	1.41		1.41	1.41	
Rip (3-tine ripper)	1.41		1.41	1.41	
Plow (conventional)	2.70		2.70	2.70	
Disc (light)	1.34		1.34	1.34	
Harrow	1.00		1.00	1.00	
Land plane	0.59		0.59	0.59	
Basal fertilizer	0.33	0.33	0.33	0.33	
Incorporate fertilizer	1.34		1.34	1.34	
Disc in herbicide	1.34		1.34	1.34	
Drill seed (4-row planter)	1.11	4.44	1.11	1.11	
Broadcast seed	0.33	0.33	0.33	0.33	
Harrow to cover seed	1.00		1.00	1.00	
Roll	0.50		0.50	0.50	
Thin		35.68			
Hand weed		47.76			
Tine weed (mechanical)	0.58		0.58	0.58	
Top dress fert. VC	0.33	0.33	0.33	0.33	
Irrigate: hand line		10.00			10.00
Spray herbicide (boom)	0.56	1.12	0.56	0.56	
Spray insecticide (boom)	0.50	1.00	0.50	0.50	
Guard crop		24.00			
On-farm transport	1.00		1.00	1.00	
Slash/burn crop residue	1.20		1.20	1.20	
Commute	0.50		0.50	0.50	
	(hr/t)	(hr/t)	(hr/t)	(hr/t)	(hr/t)
Hand pick maize	1.00	36.00	1.00	1.00	
Hand pick cotton (40 kg)		200.00			
Hand pick groundnuts		100.00			
Dry crop		2.00			
Shell maize		2.00			
Bale cotton		1.00			
Bag crop		1.00			

Data sources: Wheat (AGRITEX, Winter 1986); maize, soybeans, groundnuts, and cotton (AGRITEX 1986-87).

Note: Tobacco budgets constructed from ZTA data; no information available on cropping operations.

Table C3. Total input use per hectare

	Irrigated wheat	Irrigated maize	Irrigated soybeans	Irrigated groundnuts	Irrigated cotton
Yield (t/ha)	5.50	7.00	3.00	3.50	3.25
Labor hours: skilled	11.10	16.12	8.42	12.67	10.37
Labor hours: unskilled	163.69	372.47	111.65	575.96	915.47
Tractor hours	11.10	16.12	8.42	12.67	10.37
Tillage equipment hours	11.10	16.12	8.42	12.67	10.37
Irr. equipment hours	144.00	48.00	48.00	105.60	124.80
Contractual services					
Harvesting	Yes	No	Yes	No	No
Aerial top dress	No	Yes	No	No	No
Aerial pesticide	No	No	No	No	Yes
Cotton pack rental	No	No	No	No	Yes
Transport out	Yes	Yes	Yes	Yes	Yes
Water (1,000 m3)	7.20	2.40	2.40	5.28	6.24
Seed (kg)	120.00	25.00	100.00	100.00	25.00
Agricultural lime (kg)	250.00	250.00	250.00	300.00	250.00
Gypsum (kg)				400.00	
Fertilizer (kg)					
Ammonium nitrate	350.00	350.00			150.00
Compound D	700.00	350.00			
Compound L				350.00	400.00
Compound S			350.00		
Herbicides (l)					
Bromofenoxin 50 WP	0.40				
Wetting agent	0.10				
Terbutryne 500 FW	0.25		2.20		
Alachlor 43% EC		2.75			
Atrazine 500 FW		2.30			
Lasochlor 43% EC			3.50		
Trifluralin				1.30	1.60
Metalachlor				2.00	
Prometryne				2.50	
Cyanazine 50, 3%					3.10
Paraquat 25% EC					1.00
Pesticides (l)					
Demetron S-Methyl	0.40				
Endosulfan 35 MO		1.32	1.00		2.50
Monocrotophos 40				1.20	
Carbaryl 85 WP					2.34
Syn. Pyrethroid					1.00
Dimethoate 40 EC					0.50
Triazophos 40 EC					0.70
Molasses					50.00
Fungicide (kg)					
Chlorothalonil				9.00	
Packing materials					
Lost bags	1.00	1.54	0.66	2.25	
Lost packs					0.33
Twine (kg)	1.00	0.32	0.13	0.45	0.25

Appendix D

A Note on the Derivation of Social Prices

In this study, social prices for tradables have been derived in two different ways, depending on data availability. In the case of products for which widely recognized world reference prices are available (e.g., agricultural commodities and single-element fertilizers), social prices have been calculated in the conventional manner by starting with the world reference price (e.g., #2 Hard Red Winter Wheat, FOB Gulf Ports), adjusting for transport and handling costs, and correcting for exchange rate distortions to arrive at a world price equivalent at some reference point in Zimbabwe--in this study, Harare.

In the case of tradables for which widely recognized world reference prices are not available (e.g., farm machinery, irrigation equipment, crop chemicals), social prices have been calculated by starting with the market price in Zimbabwe and adjusting for all policy-induced effects--chiefly sales taxes, import tariffs, and exchange rate distortions. The resulting price approximates the world price equivalent at the reference point in Zimbabwe.

Social prices for non-traded tradables have been calculated based on their estimated opportunity cost value. With the exceptions of primary factors (whose pricing is discussed at length in the paper), social prices of all other non-traded tradables have been equated to actual market prices, since these prices are not subject to major policy distortions and because the markets for non-traded tradables are considered reasonably competitive.

Appendix D
Market Prices and Social Prices of Tradables

Table D1. Market prices and social prices of tradables

	Date of price	Market price (Z$/ha)	Social price (Z$/ha)
A) Inputs			
Annual machinery depreciation (Z$)			
Tractor	1986	3,562.50	2,989.96
Tillage equipment	1986	475.00	307.63
Combine	1986	11,875.00	10,284.60
Dam and pump	1986	118.75	103.91
Irrigation equipment	1986	118.75	103.91
Annual machinery repair and maintenance (Z$)			
Tractor	1986	3,562.50	2,820.31
Tillage equipment	1986	47.50	37.60
Combine	1986	11,875.00	9,401.04
Dam and pump	1986	29.69	22.27
Irrigation equipment	1986	29.69	22.27
Fuel (Z$/l)			
Tractor	1986	0.60	0.51
Combine	1986	0.60	0.51
Treated seed (Z$/kg)			
Wheat (purchased)	5/1986	0.60	0.60
Maize (single hybrid)	6/1986	1.43	1.43
Soybean	7/1986	0.72	0.72
Groundnut	11/1986	1.11	1.11
Cotton	11/1986	0.63	0.63
Fertilizer (Z$/t)			
Urea	10/1986	541.40	366.50
Ammonium nitrate	7/1986	406.00	362.50
Muriate of potash	10/1986	351.80	290.10
Triple super phosphate	1986	(not sold)	433.30
Compound D	6/1986	355.60	246.79
Compound L	11/1986	404.00	266.91
Compound S	11/1986	448.00	303.76
Compound C	11/1986	467.80	294.26
Lime	11/1986	35.00	35.00
Gypsum	11/1986	55.40	55.40
Soil treatment (Z$/kg)			
Quintozene	7/1986	7.41	7.22
Herbicides (Z$/l)			
Bromofenoxin 50 WP	5/1986	21.54	21.00
Wetting agent	5/1986	7.29	7.11
Terbutryne 500 FW	11/1986	16.70	16.28
Alachlor 43% EC	6/1986	11.27	10.99
Atrazine 80% WP	6/1986	6.93	6.76
Lasochlor 43% EC	11/1986	10.25	9.99
Trifluralin 44.5%	11/1986	6.88	6.71
Metalachlor	11/1986	25.75	25.11
Promteryne	11/1986	20.40	19.89
Cyanazine 50, 3%	7/1986	11.65	11.36
Paraquat 25% EC	7/1986	10.78	10.51

(Table continued on next page)

Table D1. (continued)

	Date of price	Market price (Z$)	Social price (Z$)
Pesticides (Z$/l)			
Demetron S-methyl	5/1986	12.63	12.31
Endosulfan 35 MO	11/1986	10.07	9.82
Monocrotophos 40	11/1986	18.61	18.14
Carbaryl 85 WP (Z$/kg)	7/1986	13.85	13.50
Syn. Pyrethroid	7/1986	56.00	54.60
Dimethoate 40 EC	7/1986	10.00	9.75
Triazophos 40 EC	7/1986	26.33	25.67
Molasses	7/1986	0.62	0.60
Fungicide (Z$/kg)			
Chlorothalonil	11/1986	20.58	20.07
Machinery hire charges			
Combine harvesting (Z$/ha)			
Wheat	1986	89.17	74.64
Soybeans	1986	89.30	77.76
Aerial chemical application (Z$7ha)	1986	13.59	13.59
Aerial fertilizer application (Z$/ha)	1986	13.65	13.65
Transport and handling (Z$/t/50 km)			
Fertilizer	1986	16.12	20.96
Wheat	1986	8.50	11.05
Maize	1986	10.35	13.46
Soybeans	1986	10.35	13.46
Groundnuts	1986	18.00	23.40
Cotton	1986	12.14	15.78
Electricity (Z$/1,000 m3)	1986	34.00	34.00
Crop insurance (% of GR/ha)			
Wheat	1986	0.0035	0.0035
Maize	1986	0.0057	0.0057
Soybeans	1986	0.0040	0.0040
Groundnuts	1986	0.0040	0.0040
Cotton	1986	0.0040	0.0040
Levies (% of GR/ha)			
Wheat	1986	0.0050	0.0050
Maize	1986	0.0070	0.0070
Soybeans	1986	0.0150	0.0150
Groundnuts	1986	0.0150	0.0150
Cotton	1986	0.0140	0.0140
Packing materials (Z$/bag)			
Bags	1986	2.05	2.05
T2 twine	1986	8.84	8.84
B) Outputs			
Wheat	1986	300.00	359.90
Maize	1986	180.00	224.80
Cotton	1986	750.00[a]	2,570.00[b]
Soybeans	1986	340.00	340.00
Groundnuts	1986	465.00	465.00
Tobacco	1986	2,500.00	4,873.80

a Blend price

b Lint price

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