SOUTHERN AFRICA: FOOD SECURITY POLICY OPTIONS

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WHEAT POLICY OPTIONS IN ZIMBABWE: A COMPARATIVE ADVANTAGE APPROACH

M. L. Morris[1]

INTRODUCTION

Zimbabwe is unusual among SADCC countries in producing most of its own wheat. From 1965 to 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 mt in each of the last three years and would have been even greater had the government not imposed limits. Wheat is currently 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 appearance in Harare of occasional 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.

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

- o Is it an efficient use of resources for Zimbabwe to produce wheat, now and in the foreseeable future?
- o If it is 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 Zimbabwe's comparative advantage among six major crops--wheat, maize, soyabeans, groundnuts, cotton, and tobacco. Crop budgets are used to assess the profitability to farmers and to the nation of each of the six crops under current and potential future production scenarios. Comparative advantage is determined by calculating the economic returns to domestic resources used in the production of each crop, measured from the point of view of the nation. Profitability calculated by this method can differ substantially from farmer profitability, because of government policy interventions. 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 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 policy makers 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 a country's comparative advantage across crops and makes possible quantification of the cost of domestic wheat production vs. the cost of importing. Thus, comparative advantage analysis has the potential to contribute to the food security dialogue in all of the SADCC 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. While the concept of comparative advantage frequently is used for regional analysis, it can also be used at the national level, as in the present study.

In a very simple example of comparative advantage, assume that one hectare 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 mt/ha, then at current international prices (adjusted for transportation costs) this cotton, if exported, will purchase about 10 mt of wheat. Since the same one hectare of land and the same given amount of other inputs will produce only 5 mt of wheat, the country is better off producing cotton for export and importing wheat. In this example, the country has 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 (RCR), which is a measure of the domestic resource cost to a country of producing a particular commodity. A number of excellent sources are available describing the rationale for and use of domestic resource cost analysis (Pearson and Monke, 1987; Byerlee and Longmire, 1986a; Pearson *et al.*, 1981). No attempt is made here to describe the methodology in detail, although the following explanation may be useful.

The resource cost ratio for a particular commodity or product is calculated by dividing production inputs and outputs into "tradeables" and "non--tradeables" and expressing the net value of non-tradeables as a proportion of the net value added to tradeables:

$$\text{RCR} = \frac{\text{Net value of non-tradeable domestic resources}}{\text{Net value added to tradeables}}$$

where: net value of non-tradeable domestic resources = value of non-tradeable inputs - value of non-tradeable outputs
Value added to tradeables = value of tradeable outputs - value of tradeable inputs

A 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 a RCR of less than one, since the country earns or saves foreign exchange in their production. Conversely, a 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 RCR's is the valuation of inputs and outputs. Market prices of inputs and outputs do not necessarily reflect true economic values in the presence of government policies such as subsidies, taxes, price restrictions, wage policies, and exchange rate controls. Consequently, before RCR's are calculated, it may be necessary to adjust market prices to eliminate the effects of policy-induced distortions. 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 "tradeable" and "non-tradeable" items. Tradeables 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. Non-tradeables are valued at their returns in the most profitable alternative use, again expressed in world price equivalents. (For more information on pricing tradeables and non-tradeables, see Pearson and Monke, 1987; and Gittinger, 1982.)

Social prices can differ substantially from market prices, such 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. When significant discrepencies 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 national point of view. 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. Comparison of farmer profitability with national profitability thus provides important insights into the impacts of government policies.

CONTEXT OF THE STUDY

Wheat was introduced into present-day Zimbabwe by European missionaries in the late 19th century, but it did not become an important crop until the *Unilateral Declaration of Independence* (1965) reduced commercial grain imports and precipitated the need for self-sufficiency in basic cereals production (Ngobese, 1987). The nation's response to this challenge was little short of remarkable. In an extremely short period, a viable wheat industry was created. Historical data indicate that the steady 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 1).

Despite the remarkable success achieved in Zimbabwe in increasing domestic wheat production, consumption of wheat has grown even more rapidly. As shown in Table 1, total wheat consumption tripled during the past two decades, and cousumption per capita rose by roughly half. The forces underlying this rapid increase in wheat consumption appear similar to those found elsewhere in Sub-Saharan Africa and indeed throughout much of the

Table 1. **Wheat data, 1965-1986, Zimbabwe.**

Year	Harvested area (ha)	Average yield (mt/ha)	Production (000mt)	Consumption (000 mt)	Net imports (000mt)	Bread price[a] (Z$/loaf)
1965	1,619	2.35	3.8	84	80.2	b
1966	4,419	2.01	8.9	108	99.1	b
1967	5,222	2.69	14.1	99	84.9	b
1968	7,325	3.58	26.2	109	82.8	0.23
1969	12,039	3.23	39.0	114	75.1	0.23
1970	15,322	3.67	56.2	116	59.8	0.25
1971	23,688	3.71	87.7	119	31.3	0.24
1972	24,276	3.39	82.2	111	28.8	0.23
1973	22,620	3.81	86.1	130	43.9	0.23
1974	26,819	3.35	89.9	141	51.1	0.23
1975	32,569	4.00	130.2	146	15.8	0.24
1976	34,282	4.29	147.2	120	(27.2)[c]	0.23
1977	44,817	3.91	175.4	125	(50.4)[c]	0.24
1978	47,708	4.27	203.9	144	(59.9)[c]	0.24
1979	36,868	4.39	162.0	169	7.0	0.21
1980	38,461	4.97	191.2	205	13.8	0.21
1981	36,845	5.46	201.2	223	21.8	0.21
1982	37,378	5.70	213.0	234	21.0	0.21
1983	23,000	5.40	124.3	227	102.8	0.21
1984	17,000	5.79	98.5	220	121.5	0.21
1985	38,037	5.40	205.5	248	42.5	0.22
1986	43,184	5.75	248.3	270	21.7	0.23

[a]1980 prices. [b]Data not available. [c]Numbers in parentheses indicate exports.
Sources: FAO, CSO, CFU

developing world--rising incomes, increasing urbanization, changes in consumer tastes and preferences, and decreases in the price of wheat relative to substitutes (Byerlee and Sain, 1986; Byerlee and Longmire, 1986b; Byerlee, 1987).

Despite the rapid growth in demand for wheat, government has not used consumer price policy to discourage consumption. Even though the Grain Marketing Board (GMB) runs a permanent deficit on its wheat trading account, indicating continuing subsidies to millers, retail bread prices have remained constant in real terms over the past two decades (Table 1). 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.

Zimbabwe is one of the few countries in Sub-Saharan Africa that has achieved anything close to self-sufficiency in wheat production. Zimbabwe actually exported modest quantities of wheat during the late 1970s, but since then demand has outpaced supply, forcing the government to import. Wheat imports increased rapidly during 1984 and 1985 after several consecutive years of drought reduced the local harvests. Although production has since recovered to long-term trend levels, the goal of self-sufficiency remains elusive (Figure 1).

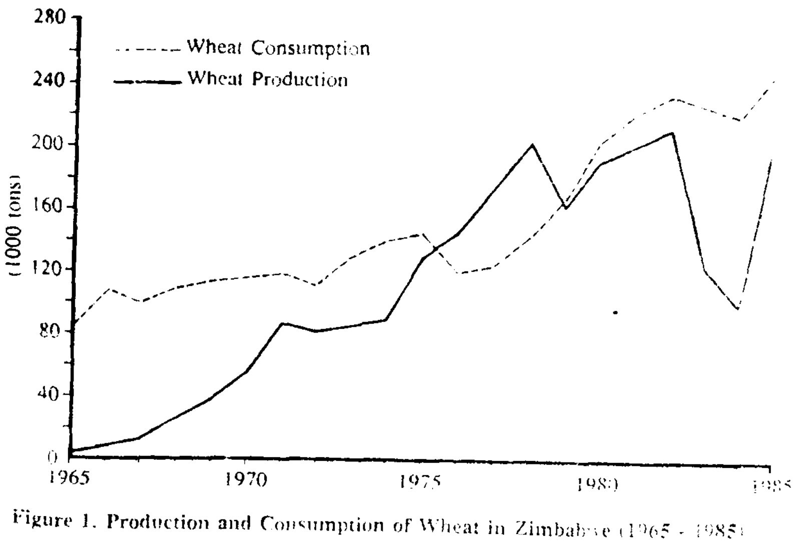

Figure 1. Production and Consumption of Wheat in Zimbabwe (1965 - 1985)

ENTERPRISE BUDGETS AND CALCULATION OF RCR'S

Sources of data for enterprise budgets

Enterprise budgets were constructed for the six major irrigated crops grown by commercial farmers in Zimbabwe (wheat, maize, soyabeans, groundnuts, cotton, and tobacco) to estimate farmer and national profitability, and to calculate resource cost ratios[2]. Budgets were also constructed for the same six crops grown under rainfed conditions, to provide a standard for comparing the economics of irrigated and rainfed agriculture. The budgets are representative of the typical commercial farm in the highveld and middleveld zones, where most of Zimbabwe's field crops are grown. (The complete enterprise budgets appear in Appendix A.)

Technical coefficients for the various crop enterprises were obtained from a number of sources. For all irrigated crops except tobacco, the primary sources of technical information were the prototypical budgets published each year by the agricultural extension service (AGRITEX) and by the Commercial Farmers Union (CFU). Tobacco data were obtained from the production files published by the Zimbabwe Tobacco Association (ZTA). Rainfed crop budgets were derived by adjusting the irrigated crop budgets to reflect differences in input use and yields.

The enterprise budgets reflect recommended levels of production technology, which closely resemble levels actually in use 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.

Finally, the enterprise budgets do not take into account non-enterprise related expenses sometimes included in farm budget analysis as "basic overhead expenses" (e.g., living expenses, accountant's fees, general insurance, personal taxes, etc). Since such 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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[2]Space limitations preclude the inclusion in the present version of the paper a complete description of the derivation of shadow prices used in the profitability analysis. For a detailed explanation of the derivation of the shadow prices used, see Morris (1988).

Farmer profitability

Farmer profitability per ha of the six irrigated crops was calculated using 1986 market prices for inputs and outputs. Results of the profitability analysis are shown in Table 2. Not surprisingly, tobacco is by far the most profitable irrigated crop from the farmer's point of view, with estimated net returns to the farmer's land, management and labour of Z$2,783/ha. Cotton is the next most profitable irrigated crop, with a net return of Z$751/ha. Wheat ranks third (Z$178/ha), followed closely by maize (Z$177/ha), groundnuts (Z$170/ha), and finally soyabeans (Z$144).

Farmer profitability per ha of the six crops grown under rainfed conditions was also calculated[3]. The farmer profitability of rainfed crops differs from that of irrigated crops in several respects. First, the absolute profitability per ha of all six crops is lower. Second, the relative profitability of the six crops changes; under rainfed conditions, tobacco (Z$852/ha) remains the most profitable crop by far, still followed by cotton (Z$259/ha), but

Table 2. Estimated farmer and national profitability (Z$/ha) of six major crops under irrigated and rainfed production, 1986, Zimbabwe[a].

	Wheat	Maize	Soyabeans	Groundnuts	Cotton	Tobacco
FARMER PROFITABILITY						
Irrigated net returns	178	177	144	170	751	2,783
Rainfed net returns	70	122	93	82	259	852
NATIONAL PROFITABILITY						
Irrigated net returns	682	679	113	684	1,550	8,703
Rainfed net returns	297	315	64	372	637	5,137

[a]Data rounded to the nearest dollar.
Source: Crop budgets

[3]The rainfed wheat budget uses Kenya data (Longmire and Lugogo, 1987), since Zimbabwe doesn't grow rainfed wheat. An average Kenyan yield of 2.5 mt/ha is assumed, comparable to DR&SS summer wheat trials (Stenhouse, 1987).

maize now ranks third (Z$122/ha), followed by soyabeans (Z$93/ha), groundnuts (Z$82/ha), and finally wheat (Z$70/ha).

National profitability

Next, the irrigated and rainfed enterprise budgets were recalculated, using social prices to assess the relative profitability of the six crops from the national point of view. As indicated previously, social prices are prices which have been corrected for policy distortions. In the initial national profitability calculations, no opportunity cost values are assigned to land and water. Subsequently, the analysis is extended by costing these two critical production inputs.

The social price of a product differs, depending on whether the product is imported or exported. If the product is imported (as in the case of wheat), transportation and handling costs must be added to the world reference price to arrive at a social price based on the import parity price. But if the product is exported (as in the case of cotton and tobacco), transportation and handling costs must be subtracted from the world reference price to arrive at a social price based on the export parity price. In this study, only wheat is considered an imported commodity. All others are considered export commodities (or potential export commodities).

National 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 2). First, the use of social prices drastically increases the profitability per ha of five out of the six irrigated crops, with only soyabeans suffering an absolute decline. Second, the relative profitability of the various irrigated crops changes very little. Tobacco (Z$8,703/ha) and cotton (Z$1,550/ha) are still the two most profitable irrigated crops, followed at some distance by groundnuts (Z$684/ha), wheat (Z$682/ha), and maize (Z$679/ha). In terms of national profitability, soyabeans (Z$113/ha) continue to lag well behind the other irrigated crops.

National profitability was next calculated for the six crops grown under rainfed conditions. As before, the use of social prices drastically increases the profitability of five out of the six rainfed crops, with only soyabeans suffering an absolute decline. From the point of view of the nation, tobacco (Z$5,137/ha) and cotton (Z$637/ha) remain the two most profitable rainfed crops, but groundnuts (Z$372/ha) now climbs to third, and maize (Z$315/ha) supplants wheat (Z$297/ha) as the most profitable grain crop. Once again, soyabeans (Z$64/ha) rank as the least profitable crop.

Comparing farmer and national profitability

The differences between farmer profitability and national profitability for each crop grown under irrigation are shown in Table 3. These differences represent the net effect per hectare of government policies. A positive difference implies that government policies on the whole favor production of a particular crop (by making production more profitable to the farmer than it is to the nation), while a negative difference implies that government policies on the whole discriminate against the production of a particular crop (by making production less profitable to the farmer than it is to the nation). The results appearing in Table 3 indicate that the net policy effect is negative for five out of the six crops grown under irrigation. Only soyabeans are favored by government policies; all of the others are discouraged.

Table 3 disaggregates the net policy effect for each crop to reveal the effects of specific government policies:

- o Producer price policy generally reduces the profitability of agriculture, in that farmers receive less than the world price equivalent (based on current world prices) for five out of the six crops. The only exception is soyabeans; soyabeans producers receive a price higher than the world price equivalent (export parity price).

Table 3. Sources of differences between farmer and national profitability (Z$/ha) of irrigated crops, Zimbabwe.[a]

Crop	Farmer profit-ability	National profit-ability	Net policy effect	Differences due to policies on: Product price	Machi-nery	Purch-ased inputs	Labour	Credit	All other[c]
Wheat	178	682	(504)	(329)	(46)	(78)	(39)	24	(36)
Maize	177	679	(502)	(336)	(43)	(48)	(89)	20	(6)
Soyabeans	144	113	30	145	(26)	(42)	(27)	15	(35)
Groundnuts	170	684	(515)	(305)	(44)	(47)	(138)	25	(6)
Cotton	751	1,550	(799)	(486)	(42)	(57)	(219)	29	(25)
Tobacco	2,783	8,703	(5,919)	(6,053)	(66)	(60)	(619)	87	791[b]

[a]Data rounded to the nearest dollar. [b]Includes effect of processing losses incurred between the auction floor and export. Farmers receive payment for the 15% of the crop that is not used (stems and veins). [c]All other policies includes energy, transport, and insurance.

Source: Crop budgets

- Policies affecting farm machinery prices also generally reduce the profitability of agriculture by making farmers pay more to purchase and maintain their machinery than they would in the absence of these policies. However, the inflationary effects of import surtax tariffs and sales taxes on farm machinery are partially offset by the over-valued exchange rate, which reduces the prices of farm machinery in terms of local currency.
- Policies affecting the prices of purchased inputs (seed, fertilizer, crop chemicals) also generally reduce the profitability of agriculture by raising market prices above world equivalent prices. The greatest effect is on nitrogen fertilizer, since continued reliance on high cost domestic manufacturing capacity results in significantly higher costs relative to world nitrogen prices.
- Labour policy, specifically minimum wage legislation, reduces the profitability of commercial agriculture by increasing the cost of farm labour. This effect is most pronounced in the case of crops requiring a high labour input (e.g., tobacco, cotton, groundnuts).
- Agricultural credit policy, specifically, the provision of AFC credit at rates several points lower than the rates offered by commercial banks, increases the profitability of agricultural production by reducing the cost of short-term credit.

Assessing the economic value of land and water

In the preceding analysis, no opportunity cost values were assigned to land or water. The underlying assumptions concerning land are that it is wholly owned by the farmer (hence no mortgage or rental costs are included in the farmer profitability analysis), and that it is not a limiting resource (hence no opportunity costs for land are included in the national profitability analysis).

Similarly, the underlying assumption concerning water is that water is not a limiting resource (hence the only water-related costs included in the profitability analysis are 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).

Although it is possible to envision scenarios in Zimbabwe in which neither land nor water has an opportunity cost, typically farmers must decide how to allocate limited amounts of land and/or water between several alternative cropping enterprises. In such cases, land and/or water has an opportunity cost: in choosing to allocate land and water to a particular crop, the farmer must forego the revenue which might have been generated by allocating the same resources to an alternative crop. Consequently, domestic resource cost analysis is more meaningful when land and water are valued at their opportunity cost.

Determining the opportunity cost value of land

In theory, the opportunity cost value of land planted to a particular crop is simply the net returns to the land in its most profitable alternative use. In practice, application of this 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 the analysis presented in this paper pertains specifically to "typical" highveld and middleveld wheat farms, three simplifying assumptions can be made concerning alternative uses of agricultural land:

- o Irrigated wheat is the only commercially viable winter crop. While some winter barley is grown under contract to the breweries, the market for barley is limited, and the feed value of barley is too low to warrant its production. Therefore, during winter the next most economic alternative to growing wheat is to leave land idle, and the opportunity cost of land in wheat production is zero.
- o 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 to the nation in rainfed tobacco production, or Z$5,137/ha.
- o Cotton, soyabeans, groundnuts, and maize are all summer crops which can be grown on the same land under either irrigated or rainfed regimes. Therefore, the opportunity cost value of land in irrigated soyabean, groundnut, 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, groundnuts production, or Z$684/ha.

Determining the opportunity cost value of water

As in the case of land, the theoretical opportunity cost value of irrigation water is the net returns to the water in its most profitable alternative use. However, in practice net returns to irrigation water depend on many factors, particularly the application method and its timing in the biological growth cycle of the crop. Consequently, precise calculation of the net returns to irrigation water 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).

This study uses a simple method to estimate the opportunity cost 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. (For the sake of simplicity, evaporation losses incurred in storing water from the rainy season into the dry season are ignored.) Depending on whether farmer profitability figures or national profitability figures are used, the result represents either the "farmer value" of water or the "national value" of water applied to each crop.

The values for irrigation water obtained using this method are shown in Table 4. Not surprisingly, one unit of water applied to tobacco is associated with a greater increase in farmer net returns than one unit of water applied to any other crop. Water applied to cotton is associated with the next greatest increase in farmer net returns, followed by water applied to maize, soyabeans, groundnuts, and wheat. 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) and/or oilseeds (groundnuts and soyabeans) only when the irrigation requirements of tobacco and cotton have been satisfied (Pilditch, 1987).

Table 4. Average value (net returns) of irrigation water by crop, 1986, Zimbabwe[a].

Crop	Amount of irrigation	Farmer benefits[b]:				National benefits[b]:			
		Irrigated	Dryland	Value of irrigation[c]		Irrigated	Dryland	Value of irrigation[c]	
	mm	(Z$/ha)		(Z$/ha)	(Z$/mm)	(Z$/ha)		(Z$/ha)	(Z$/mm)
Wheat	720	178	70	108	0.15	682	297	385	0.53
Maize	240	177	122	55	0.23	678	315	363	1.51
Soyabeans	240	144	93	51	0.21	113	64	49	0.20
Groundnuts	528	170	82	87	0.17	684	372	312	0.59
Cotton	624	751	259	492	0.79	1,550	637	913	1.46
Tobacco	380	2,783	852	1,932	5.08	8,703	5,137	3,565	9.38

[a]Data rounded to nearest dollar. [b]Net returns [c]Difference due to irrigation.
Source: Crop budgets

The national values of irrigation water shown in Table 4 differ somewhat from the farmer values. Although water is still associated with the greatest increases in net returns when applied to tobacco, from the point of view of the nation, water has approximately equal value when applied to maize or cotton. Wheat and groundnuts represent the next most profitable uses of water, followed at some distance by soyabeans.

Calculating resource cost ratios

Resource cost ratios for each irrigated crop were calculated to provide quantitative measures of comparative advantage. Inputs and outputs were classified as tradeable or non-tradeable. Tradeable items were valued at their world price equivalent (social price). These included all outputs, as well as farm machinery depreciation, fuels and oils, and imported purchased inputs (fertilizers, crop chemicals). In addition, 75% of farm machinery repairs and maintenance costs, 50% of transport costs, and 50% of machinery hire charges were also classified as tradeable items and were valued at their world price equivalent (social price).

Non-tradeable items were valued at their actual market price, except for capital, labour, land, and water. Non-tradeable items valued at market prices included lime and gypsum, packing materials, drying costs, insurance, crop levies, electricity, interest payments, 25% of farm machinery repairs and maintenance costs, 50% of transport costs, and 50% of machinery hire charges. A real cost of capital of 10% was assumed, reflecting what is thought to be the opportunity cost of capital in Zimbabwe, net of taxes.

Land and water were assigned several opportunity cost values, depending on whether land or water was assumed to be the limiting factor in production. In the land-limiting case, the value assigned to land represents the residual returns to land in the best competing alternative use valued at world price equivalent, and the value assigned to water is simply the procurement cost (storage and pumping). In the water limiting case, no opportunity cost value is assigned to land, but the value assigned to water represents the procurement cost plus the average value of the water in the best competing alternative use valued at world price equivalent.

Land limiting case

Table 5 shows the resource cost ratios for the six irrigated crops when land is the limiting factor of production. In the land-limiting case, 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 0.44 associated with wheat signifies that Z$0.44 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 value of zero.

Water limiting case

Table 5 also shows the resource cost ratios for the six irrigated crops when water is the limiting factor of production. In the water-limiting case, only one irrigated crop--tobacco--has a resource cost ratio below one, reflecting a comparative advantage in production. All of the other resource cost ratios are driven above one in the water-limiting case by the high opportunity cost value assigned to water used in tobacco production. During times of drought, clearly the most efficient use of water from the point of view of the nation is to irrigate tobacco.

Land and water limiting case

The land-limiting and water-limiting cases examined above are overly simplistic. Most commercial farmers typically operate under a combination of land and water constraints. For example, they may have enough water to irrigate only part of their farm, and at the same time variability in land types and soil conditions may preclude free substitution among crops. Often in such instances, the critical question facing farmers is the following: assuming there is enough water available to irrigate the entire tobacco crop, what crop(s) should next be irrigated? Table 5 also shows the resource cost ratios for the six irrigated crops when land and water are both limiting factors of production. In this case, the opportunity cost values assigned to water are initially the same as in the water-limiting case, and the most profitable course of action is to irrigate tobacco. However, assuming that not all land is suitable for tobacco production, eventually land becomes a limiting

Table 5. Resource cost ratios of irrigated crops, 1986, Zimbabwe.

Limiting factor	Wheat	Maize	Soya-beans	Ground-nuts	Cotton	Tobacco
Land	0.44	1.86	4.84	1.99	0.66	0.66
Water	6.13	2.54	6.70	5.16	3.08	0.25
Land & water	1.35	0.70	1.69	1.28	0.78	0.25

Source: Calculated from crop budgets.

factor as well. If water is left over after all available "tobacco soils" have been planted to tobacco, the opportunity cost value 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 to tobacco, the opportunity cost value for water reverts 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 5, when this lower opportunity cost value for water is used, the resource cost ratios associated with maize (0.70) and cotton (0.78) both drop below one. These results indicate that in times of drought, once the tobacco crop has been taken care of, Zimbabwe has a comparative advantage in maize and cotton production. The resource cost ratio associated with wheat remains above one (1.35), 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 revealed by the analysis presented above is that existing agricultural policies provide incentives for commercial farmers to plant those crops in which Zimbabwe currently has a comparative advantage. The budgets calculated for irrigated wheat, maize, soyabeans, groundnuts, cotton, and tobacco confirm what many farmers already know: although all six of the crops generate positive net returns, it is most profitable to concentrate first on tobacco and second on cotton. The resource cost ratios calculated using national 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 advantage to the nation in using the remaining water to apply supplementary irrigation to maize.

If DRC analysis fails to reveal any major policy-induced distortions between crops, several interesting policy effects become evident through the use of social prices.

First, producer price policy in Zimbabwe discriminates against five out of the six crops examined in this study, in the sense that producers receive less for their crops than the world price equivalent. (Recall that the world price equivalent is based on the import parity price in the case of wheat, and on export parity prices in the cases of the other five crops.) Only soyabeans prices are higher than what they would be in the absence of price controls. Thus, producer price policy on the whole taxes commercial agriculture.

Second, a number of government policies affect the prices paid by farmers for their machinery and purchased inputs. Taxes (e.g., import surtax tariffs and sales taxes) exert upward pressure on production costs, 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.

Third, labour 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 labour, inducing employers to substitute capital for labour 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.

Fourth, wheat can be a profitable crop for farmers in Zimbabwe, although it is probably true that many wheat growers are forced to accept smaller margins on wheat than they earn on some of the summer crops. Significantly, as long as irrigation water is readily available, wheat is also profitable from the national point of view. But in times of drought, when farmers must choose between irrigating wheat and irrigating other crops, it is more profitable from the points of view both of farmers and of the nation to use water on tobacco, maize, and cotton.

Effects of possible future developments

Technological change

At present, two factors discourage rainfed wheat production in Zimbabwe. First, improved germplasm is lacking: most available summer wheat varieties are heat intolerant, low yielding, and highly susceptible to diseases, especially rust. Second, economics dictates against rainfed wheat production: rainfed wheat must compete for land with other more profitable summer crops. However, these two barriers might be overcome. DR&SS breeders are presently working on developing improved germplasm with higher yield potential and enhanced disease resistance in the warmer summer temperatures. While average yield levels are still modest (in the range of 2-2.5 t/ha), breeders remain optimistic that that significant progress is possible over the medium to long term, particularly in high altitude regions (Stenhouse, 1987).

If and when improved germplasm becomes available, the second constraint might take care of itself. Sensitivity analysis of the rainfed-wheat budget allows calculation of the likely farmer profitability of summer wheat production under a range of assumed yields. Table 6 shows the estimated returns to land and management of rainfed wheat production under different yield levels, compared to the estimated returns to land and management of competing rainfed crops. At a yield of 2t/ha, summer wheat production would still be unprofitable. At a yield of 2.5 t/ha, the farmer could expect to earn positive net returns of Z$70/ha, but these would be too low to make summer wheat competitive with other rainfed crops. At a yield of 3 t/ha, wheat might begin to enter into the rotation, since the estimated net returns of Z$214/ha would make wheat more profitable than maize from the farmers' point of view.

Changes in input and output prices

How are future changes in world prices likely to affect Zimbabwe's current pattern of comparative advantage? The profitability of the six irrigated crops was recalculated using projected future prices for outputs and fertilizers. Table 7 shows net returns to land and management at current (1986) prices compared to net returns at projected (year 2000) prices, which were estimated by adjusting current prices upward or downward by the percentage changes forecast by World Bank commodity price analysts (World Bank, 1985). When the projected year 2000 prices are substituted for current prices in the budgets, the estimated profitability of the the six crops shows little change. Tobacco (Z$9,187/ha) remains the most profitable crop by far, followed by cotton (Z$4,658/ha), with wheat (Z$976), groundnuts (Z$817), and maize (Z$736) once again bunched some distance behind. Again, soyabeans (Z$190) trails all other crops.

These figures suggest that future developments in global commodities markets probably will not eliminate Zimbabwe's current comparative advantage in tobacco and cotton production. While 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 10 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 in order for these two traditional export crops to be displaced.

Restrictions on agricultural trade

Political developments in South Africa, to the extent that they have economic consequences, could affect Zimbabwe's current structure of comparative advantage, with important implications for food policy. In particular, further

Table 6. Profitability of rainfed wheat (Z$/ha) at four yield levels, compared to the profitability of four competing rainfed crops[a].

Rainfed crops	Net returns to land and management at: Market prices	Social prices
Rainfed wheat at:		
1.5 t/ha yield	(218) [b]	(47) [b]
2.0 t/ha yield	(74) [b]	125
2.5 t/ha yield	70	297
3.0 t/ha yield	214	469
Maize	122	315
Soyabeans	93	64
Groundnuts	82	372
Cotton	259	637
Tobacco	852	5137

[a]Data rounded to the nearest dollar. [b]Negative net returns.
Source: Crop budgets

Table 7. Profitability (Z$/ha) of irrigated crops at projected prices compared to current prices, Zimbabwe[a].

Irrigated crops	National net returns of land and management at: 1986 prices [b]	Year 2000 prices [b]
Wheat	682	976
Maize	679	736
Soyabeans	113	190
Groundnuts	684	817
Cotton	1550	4658
Tobacco	8703	9187

[a]Data rounded to the nearest dollar. [b]Assumes water is not a limiting factor of production.
Source: Crop budgets

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.

These qualitative conclusions concerning the likely effects of trade restrictions are borne out by sensitivity analysis of the irrigated crop budgets. Table 8 shows the estimated national 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 three. As expected, the profitability of wheat increases relative to that of the other crops.

Table 8. Estimated national profitability of irrigated crops under a "restricted-trade" scenario, Zimbabwe.

Irrigated	National net returns (Z$/ha) to crop land and management under:	
	Free trade	Restricted trade[a]
Wheat	682	1375
Maize	679	35
Soyabeans	113	(260) [b]
Groundnuts	684	395
Cotton	1550	964
Tobacco	8703	8200

[a]Railage and handling charges to port increased. [b]Indicates negative net returns.

Source: Crop budgets

Thus, trade restrictions would have important implications for wheat policy. Since the national 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. If the trade restrictions also affect other SADCC countries, it is likely that Zimbabwe would additionally be able to export wheat to some of its neighbours.

CONCLUSION

Agricultural policy makers 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 been able to keep pace with demand has necessitated wheat imports, creating a drain on scarce foreign exchange and heightening concerns about the erosion of national food security. The question of whether or not wheat production should be expanded thus assumes critical importance in the food policy debate.

This paper has presented preliminary results from a study 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. Comparative advantage was measured by calculating resource cost ratios for six major commercial crops under several land-limiting and water-limiting scenarios to determine which crops represent the most efficient use of domestic resources.

The results presented above suggest that agricultural policies in Zimbabwe provide incentives for commercial farmers to allocate scarce resources to those crops which are most profitable from the national point of view (tobacco and cotton, in most instances). The results also reveal how government policies affect the economics of farming, sometimes positively (as in the case of subsidized agricultural credit programs), but more usually negatively (as in the case of controlled producer prices, taxes on inputs, and wage policies).

One important finding is that wheat production represents an efficient use of Zimbabwe's resources in periods 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, another finding is that 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 this means they will not have enough water to irrigate tobacco.

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, indicating that future developments in world commodity markets are unlikely to warrant drastic changes in Zimbabwe's internal agricultural policies: 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, indicating that a shift in production patterns would be appropriate should access to a deep water port become restricted.

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Appendix A1. Irrigated crop budgets, 1986 market prices, Zimbabwe[a]

Crop	Wheat	Maize	Soya	G'nuts	Cotton	Tob-acco
Assumed Yield	5.50	7.50	3.00	3.50	3.25	3.00
GROSS RETURNS	1650	1350	1020	1628	2438	7500
FIXED COSTS						
Irrigation Costs:						
Dam and pump	86	29	29	63	74	45
Irrigation equip.	86	29	29	63	74	45
Farm Machinery Costs (depreciation):						
Tractor	68	98	51	77	63	122
Tillage equip.	9	13	7	10	8	16
Tobacco Barns & Sheds	0	0	0	0	0	163
VARIABLE COSTS						
Machinery Operating Costs						
Tractor: Fuel & Oil	50	73	37	57	47	123
R & M[b]	68	98	51	77	63	200
Tillage Equip: R & M[b]	1	1	1	1	1	0
Purchased Inputs:						
Seed & treatment	72	36	72	111	16	5
Fertilizer & lime	400	275	166	174	231	391
Herbicides	14	47	73	111	58	478
Pesticides	5	13	10	22	168	0
Fungicides	0	0	0	185	0	0
Packing materials	11	9	3	9	8	38
Irrigation Costs:						
Electricity	245	82	82	180	212	129
R & M[b]	21	7	7	16	19	11
Contract Hire Services:						
Aerial application:						
Pesticides	0	0	0	0	136	55
Fertilizer	0	14	0	0	0	0
Combine harvesting	89	0	89	0	0	0
Transport	47	78	31	63	39	355
Other Costs:						
Fertilizer						
Transport/handling	21	15	10	17	13	0
Crop insurance	6	8	4	7	10	364
Drying	3	0	3	0	0	479
Levy	8	9	15	24	34	167
Labour Costs:						
Skilled labour	7	10	5	8	6	12
Unskilled labour	78	178	53	276	438	1237
Interest on working capital (6 months)	80	66	49	93	104	281
TOTAL FIXED COSTS	248	168	115	213	220	391
TOTAL VARIABLE COSTS	1224	1005	761	1245	1467	4325
TOTAL COSTS	1472	1173	876	1458	1686	4717
NET RETURNS TO MANAGEMENT AND LAND	178	177	144	170	751	2783

[a]Data rounded to the nearest Z$. [b]Repairs and maintenance.

Appendix A2. Irrigated crop budgets, 1986 social prices, Zimbabwe[a]

	Wheat	Maize	Soya	G'nuts	Cotton	Tob-acco
Assumed Yield	5.50	7.50	3.00	3.50	3.25	3.00
GROSS RETURNS	1979	1686	875	1933	2923	12428
FIXED COSTS						
Irrigation Costs:						
Dam and pump	75	25	25	55	65	39
Irrigation-equip.	75	25	25	55	65	39
Farm Machinery Costs: (depreciation)						
Tractor	57	82	43	65	53	102
Tillage equip.	6	8	4	7	5	11
Tobacco Barns & Sheds	0	0	0	0	0	163
VARIABLE COSTS						
Machinery Operating Costs:						
Tractor: Fuel & oil	43	62	32	49	40	113
R & M[b]	54	78	41	61	50	161
Tillage equip. R & M[b]	1	1	1	1	1	0
Purchased Inputs:						
Seed & treatment	72	36	72	111	16	5
Fertilizer & lime	308	222	115	126	170	266
Herbicides	13	46	71	109	56	526
Pesticides	5	13	10	22	164	0
Fungicides	0	0	0	181	0	0
Packing materials	11	9	3	9	8	38
Irrigation Costs:						
Electricity	245	82	82	180	212	129
R & M[b]	16	5	5	12	14	8
Contract Hire Services:						
Aerial application:						
Pesticides	0	0	0	0	136	55
Fertilizer	0	14	0	0	0	0
Combine harvesting	75	0	75	0	0	0
Transport	61	101	40	82	51	390
Other Costs: Fertilizer						
Transport/handling	27	20	13	22	17	0
Crop insurance	7	10	4	8	12	364
Drying	3	0	3	0	0	240
Levy	10	12	13	29	41	167
Labour Costs:						
Skilled labour	7	10	5	8	6	12
Unskilled labour	39	89	27	138	219	619
Interest on working capital (6 months)	90	73	55	103	109	278
TOTAL FIXED COSTS	212	141	97	181	188	355
" VARIABLE COSTS	1085	867	664	1067	1185	3371
TOTAL COSTS	1297	1008	762	1248	1373	3725
NET RETURNS TO MANAGEMENT & LAND	682	679	113	684	1,550	8703

[a]Data rounded to the nearest Z$. [b]Repair and maintenance.

Appendix A3. Rainfed crop budgets, 1986 market prices, Zimbabwe[a].

	Summer Wheat[b]	Maize	Soya	G'nuts	Cotton	Tobacco
Assumed Yield	2.50	4.50	2.00	2.00	1.50	2.00
GROSS RETURNS	750	810	680	930	1125	5000
FIXED COSTS						
Farm Machinery Costs: (depreciation)						
Tractor	68	80	51	77	63	122
Tillage Equip.	9	11	7	10	8	16
Tobacco Barns & Sheds	0	0	0	0	0	163
VARIABLE COSTS						
Machinery Operating Costs:						
Tractor:						
Fuel & oil	50	59	38	57	46	123
R & M[c]	68	80	51	77	63	200
Tillage equip.						
R & M[c]	1	1	1	1	1	0
Purchased Inputs:						
Seed & treatment	72	36	72	111	16	5
Fertilizer & lime	200	138	83	87	116	195
Herbicides	14	47	73	111	58	478
Pesticides	5	13	10	22	168	0
Fungicides	0	0	0	185	0	0
Packing materials	11	9	3	9	4	38
Contract Hire Services:						
Aerial application:						
Pesticides	0	0	0	0	136	55
Fertilizer	0	14	0	0	0	0
Combine harvesting	89	0	89	0	0	0
Transport	21	47	21	36	18	355
Other Costs:						
Fertilizer						
Transport/handling	10	8	5	8	6	0
Crop insurance	3	5	3	4	5	364
Drying	1	0	2	0	0	167
Levy	4	6	10	14	16	167
Labour Costs:						
Skilled labour	7	8	5	8	6	12
Unskilled labour	9	103	30	153	211	1091
Interest on working						
Capital (6 months)	39	40	34	61	60	285
TOTAL FIXED COSTS	77	91	58	87	72	301
TOTAL VARIABLE COSTS	603	597	529	760	794	3847
TOTAL COSTS	680	688	587	848	866	4148
NET RETURNS TO MANAGEMENT & LAND	70	122	93	82	259	852

[a]Data rounded to the nearest Z$. [b]Estimated based on data from Kenya. [c]Repairs and maintenance.

Appendix A4. Rainfed crop budgets, 1986 social prices, Zimbabwe[a]

	Summer wheat[b]	Maize	Soya	G'nuts	Cotton	Tob-acco
Assumed Yield	2.50	4.00	2.00	2.00	1.50	2.00
GROSS RETURNS	900	899	583	1105	1349	8285
FIXED COSTS						
Farm Machinery Costs (depreciation):						
Tractor	57	67	43	65	53	102
Tillage equip.	6	7	4	7	5	11
Tobacco Barns & Sheds:	0	0	0	0	0	163
VARIABLE COSTS						
Machinery Operating Costs:						
Tractor:						
Fuel & oil	43	50	32	49	40	113
R & M[c]	54	63	41	61	50	161
Tillage equip.						
R & M[c]	1	1	1	1	1	0
Purchased Inputs:						
Seed & treatment	72	36	72	111	16	5
Fertilizer & lime	161	115	63	68	90	142
Herbicides	13	46	70	109	56	526
Pesticides	5	13	10	22	164	0
Fungicides	0	0	0	181	0	0
Packing materials	11	9	3	9	4	38
Contract Hire Services:						
Aerial application:						
Pesticides	0	0	0	0	136	55
Fertilizer	0	14	0	0	0	0
Combine harvesting	75	0	75	0	0	0
Transport	28	54	27	47	24	293
Other Costs:						
Fertilizer						
Transport/handling	14	10	6	11	8	0
Crop insurance	3	5	2	4	5	364
Drying	1	0	2	0	0	240
Levy	5	6	9	17	19	167
Labour Costs:						
Skilled labour	7	8	5	8	6	12
Unskilled labour	5	51	15	77	105	546
Interest on working						
Capital (6 months)	45	43	39	69	65	213
TOTAL FIXED COSTS	63	74	47	71	58	276
TOTAL VARIABLE COSTS	540	510	471	661	654	2873
TOTAL COSTS	602	584	519	732	712	3148
NET RETURNS TO						
MANAGEMENT & LAND	297	315	64	372	637	5137

[a]Data rounded to the nearest Z$. [b]Estimated based on data from Kenya. [c]Repairs and maintenance