Policy Options to Stabilize Food Supplies: A Case Study of Southern Africa.
By Michael A. Trueblood, Shahla Shapouri, and Shida Henneberry. Market and Trade Economics Division, Economic Research Service, U.S. Department of Agriculture. Agriculture Information Bulletin 764.

Abstract

For the southern Africa region, both a grain stocking program and an import insurance program would have reduced food supply variability more than historical food aid during 1970-95. The stocking program and the import insurance program would have been less expensive than food aid from a donor point of view. These options may be attractive policy alternatives for donors and countries in other regions, given the decline in food aid budgets in recent years and projections of rising global food gaps.

Keywords: Food security, supply stabilization, food aid, Southern Africa Development Community (SADC), grain stocks, and import insurance.

Acknowledgments

The authors gratefully acknowledge Mary Bohman, John Dunmore, Bill Lin, Lorrie Mitchell, Paul McNamara, Vernon Ruttan, and Romeo Bautista for helpful reviews. Dirk Kok of the South African Grain Silo Industry, Ltd. was very gracious in providing valuable grain silo storage costs information. Roger Buckland of the SADC Food Security Unit and officials at the Southern African Transportation and Communication Commission (SATCC) were also very helpful in providing background information that was used in the preparation of this report. Special thanks to Lindsay Mann and Thomas McDonald for their editorial help and to Curtia Taylor for design and production.

1800 M Street, NW
Washington, DC 20036-5831 June 2001

Contents

Summary

For the southern Africa region, both a grain stocking program and an import insurance program would have reduced food supply variability more than historical food aid during 1970-95. The stocking program and the import insurance program would have been less expensive than food aid from a donor point of view. These options may be attractive policy alternatives for donors and countries in other regions, given the decline in food aid budgets in recent years and projections of rising global food gaps.

Different policy options have been proposed over the years to address aggregate food insecurity. Food aid has been used historically but has had limited success in preventing food supply shortages in most lower income countries. Food aid often fails to meet shortrun deficits in many countries; moreover, longrun trends show that food aid supplies have declined while demand has been growing.

This report considers two alternative regional policy options: a grain stocking program and a grain import insurance program approach. It compares the relative effectiveness of these options with food aid, using a counterfactual approach for 1970-95. The countries of the Southern Africa Development Community (SADC) were chosen as a case study for several reasons, including a history of regional cooperation, a common staple (white maize), and high variability in food production and overall supply. Political changes in South Africa also provide an opportunity to re-examine some policy options now that it has joined SADC.

Compared with food aid, both the stocking program and import insurance program would reduce supply variability. The stocking program would hold grain stocks in the region whereas the insurance program would make sure that countries could afford to purchase grain on the world market when necessary. The stocking program reduces supply variability more than the insurance program does, but both provide a safety net. For most SADC countries, the differences between the stocks and insurance in terms of per capita supply reductions are relatively small for most countries but are significant for a few countries.

The stocking program and possibly the insurance program could be less expensive for donors than the costs of food aid. The cost of the insurance program may be slightly more expensive depending on the setup costs. This finding depends on the unique situation of SADC countries. The costs of the stocking program option were estimated by assuming all regional grain stocks would be stored in South Africa, which has surplus storage capacity built up from the apartheid era. Even with high transportation costs, the total cost adjusted for inflation for all SADC countries would have been about $1.4 billion for 1970-95 (lowest of the options). The grain import insurance program would have cost about $2.6 billion for the same period (excluding a one-time startup charge). For food aid, the assumption is made that the historical food aid volumes would have been replaced by commercial import purchases, leading to total estimated expenditures of $2.7 billion for 1970-95.

Earlier studies likewise concluded that alternatives to food aid may be more effective in stabilizing food supplies in a less costly and more efficient manner. This would seem to suggest that these results are not limited to the SADC countries and may be applicable to other regions as well. On the other hand, it is important to point out that the stocking results may be unique to this region because South Africa built up excess modern storage capacity in the apartheid years. Similar studies of other regions may not find the storage program option more cost effective when new capital construction costs are factored in.

Policy Options to Stabilize Food Supplies

A Case Study of Southern Africa

Michael A. Trueblood, Shahla Shapouri, and Shida Henneberry

Introduction

The issue of improving global food security has been at the center of policy discussions since the World Food Summit in 1996. A commonly accepted definition of food security is "access by all people at all times to enough food for an active and healthy life" (World Bank, 1986). This definition encompasses both supply and demand dimensions. However, the first step toward achieving food security requires having adequate supplies at the aggregate level.

There are two sources of food insecurity that occur at the aggregate level. One source is inadequate levels of food supplies. This slowly developing problem tends to be more noticeable when one examines underlying food supply trends, which have been declining in many countries. Another source of insecurity is high annual food supply variability, which in shortfall years can lead to severe hardship. The hardship often occurs in years of low domestic production when countries are unable to muster the adequate foreign exchange necessary to import commercially the food quantities that would cover the deficit.

Different policy options have been proposed over the years to address aggregate food insecurity. External assistance, particularly food aid, has been used historically but has had limited success in preventing food supply shortages in most lower income countries. Although donors commit to providing food aid, the quantities often have been inadequate to meet the shortrun deficits in many countries. Moreover, longrun trends show that the volume of food aid has declined over time while the demand has been growing. Therefore, in the policy debate related to options to safeguard food security, "self-reliance"—the ability to commercially import the levels of food to meet consumption requirements—is what most countries are considering. In this environment, in addition to self-help measures, one policy option is regional collaboration, which can play a crucial role in both reducing short-term instability in food supplies and attracting the cooperation of donors to improve the long-term food security of countries.

This report examines regional policy alternatives that can stabilize aggregate food supplies. The policy options that are considered include a grain stocking program and a grain import insurance program approach. These options can be considered only a first step toward achieving food security at the national level. Demand-side considerations that affect direct consumer access, such as income inequality, geographic isolation and programs that target vulnerable populations, are beyond the scope of this study.

This report is motivated by a desire to find food security policy options that are economically more efficient than food aid deliveries, which can allow resources to be used for other purposes. Budgetary pressures among the major food aid donor countries, which have led to reduced food aid budgets over the last decade, have contributed to the interest in such alternatives.[1] These alternative programs may have the additional benefit of being less intrusive to markets than food aid, which is discussed in more detail in the conclusions section.

The Southern Africa Development Community (SADC) region was chosen as a case study to examine alternative programs for several reasons.[2] One reason

[1] Food aid allocation decisions are usually beyond the control of recipient countries.

[2] The countries of SADC now include Angola, Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe. After this study was begun, the Democratic Republic of Congo and Seychelles applied for membership in the organization. These countries have been excluded from the analysis.

is that the SADC region is representative of other countries and regions where food aid imports had been rising before the recent budgetary pressures forced food aid donations downward. Another consideration is that the political changes in South Africa, which joined SADC in 1994, require a re-examination of the previously discussed policy options that now include South Africa in the analysis because this country accounts for about 55 percent of the region's total grain production.[3] Another factor is that, despite the region's most recent political problems, SADC would appear to be a good candidate to implement regional policy options given its history of cooperation.[4] Finally, consumers in the region have in common that they prefer the staple of white maize (UNFAO/CIMMYT, 1997).

The primary goal of this study is to examine whether the two policy options under consideration, grain stocks and grain import insurance, are more efficient and cost effective than food aid in stabilizing food supplies in the SADC countries from a donor point of view. The effectiveness of the different options in stabilizing supply is evaluated by determining the reductions in the standard deviation of per capita grain supplies. The costs of the policy options considered are evaluated in aggregate and on a per capita basis across countries. Although food aid has no cost to recipient countries, it has a similar goal of stabilizing food supplies.

The potential effectiveness of implementing these policy options in the future is considered by reviewing how the programs would have performed historically using model simulations with actual data. For the 1970-95 period, this report finds both the insurance program and stocking program would have been more effective policy tools in reducing supply variability in most countries compared with the status quo (food aid). Among the two policy options, the stocking program showed a slightly greater average reduction in supply variation. The stocking program and possibly the insurance program could be less expensive for donors than the costs of food aid.[5]

[3] A regional stocking program, similar to the one examined here, was analyzed by Technosynesis, 1984. A key feature of this now outdated study was that stocks would be held decentrally throughout the region. It appears that this proposal was not implemented due to unclear policy objectives and other administrative issues (Hay and Rukuni, 1988). This report examines an alternative proposal: that stocks be held in South Africa to take advantage of its excess storage capacity.

[4] Robson (1997) argues that the southern African countries have had a strong record of cooperation after they formed the Southern African Development Coordination Council (SADCC, the predecessor to SADC) in 1980 since there was a common regional goal to reduce economic dependence on (apartheid-era) South Africa. One could argue also that the continued existence of the Southern African Customs Union (SACU), which is one of the oldest operating customs unions in the world, supports the claim that the region has a strong history of cooperation.

[5] As explained later, the insurance program requires a startup fund. Under a minimum level criterion, the program would be slightly more expensive than food aid.

Background: Food Security in Southern Africa

Income levels vary widely in southern Africa and are clearly linked to per capita food consumption. Mozambique, which is recovering from civil war, has one of the world's lowest per capita income levels ($140; all dollar amounts are expressed as U.S. dollars), while Mauritius has the region's highest per capita income of $3,870 (World Bank, 1998). Nine of the 12 SADC countries recorded positive per capita growth rates over the 1988-97 period (table 1). The fastest growing economies on an annual per capita basis were Mauritius and Botswana, both over 4 percent. Only Angola, which has continued to experience political instability, has shown a highly negative growth rate (-8 percent).

The SADC region averages 2,231 calories per person per day, which is below the world average of 2,760. Average daily per capita calorie consumption is highest in Mauritius (2,923) and South Africa (2,956) where incomes are highest, while consumption is below the nutritional requirement of 2,100 calories as recommended by FAO in the poorer countries like Angola (1,900), Mozambique (1,782), and Zambia (1,958). Regionally, grains account for 53 percent of total calorie availability, which is one reason why this report focuses on this commodity group. Another reason is that grains are the largest component of global food aid.

The structure of grain food supplies has changed considerably in recent decades. In previous decades, Angola, Malawi, Zambia, Zimbabwe, and South Africa were all net grain-exporting countries (table 2). Recently, only Zimbabwe and South Africa have been net grain exporters (fig. 1). Generally, grain production growth has not kept pace with consumption, leading to a greater reliance on imports. This is a cause for concern since consumers in the region previously have shown a strong preference for the staple grain white maize, which is not widely traded on world grain markets.[6] Moreover, because of the financial difficulties in some countries, the region has slowly become more reliant on food aid in recent decades (fig. 2).

Finally, one of the most distinguishing features about southern Africa is its relatively high variability in food production compared with other regions around the world. One measure of variability is the coefficient of

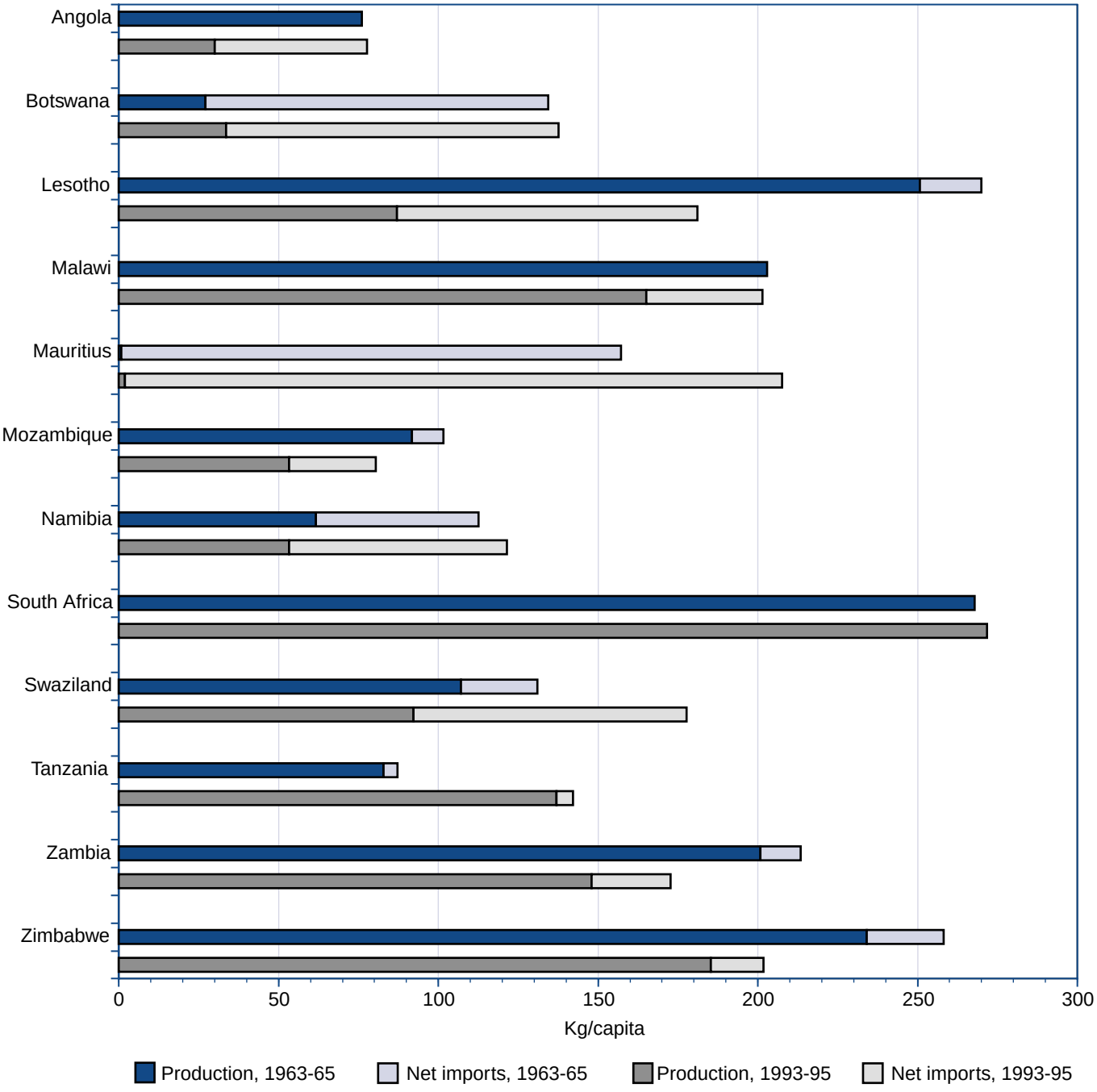
[6] It is unclear how much consumers are willing to switch to other grains. Missiaen (1995) showed that consumers were willing to purchase maize meal that was blended with yellow and white varieties only after a relatively large price discount had been offered.

Table 1—Per capita incomes and calorie consumption levels

Country	Per capita GNP, 1997	Annual real per capita GNP growth rate, 1988-97	Average per capita calorie supplies, per day, 1995-97	Average share of grains in calorie supplies, 1995-97
	Dollars	*Percent*	*Number*	*Percent*
Angola	260	-8.5	1,900	31.4
Botswana	3,310	4.0	2,228	49.4
Lesotho	680	1.4	2,236	75.3
Malawi	210	1.3	2,068	68.4
Mauritius	3,870	4.1	2,923	44.3
Mozambique	140	2.7	1,782	41.5
Namibia	2,110	2.1	2,141	48.9
South Africa	3,210	-.7	2,956	52.9
Swaziland	1,520	1.6	2,479	50.5
Tanzania	210	0.7	2,000	48.7
Zambia	370	-.9	1,958	66.2
Zimbabwe	720	0	2,095	61.5
SADC	1,420	-0.6	2,231	53.2

Source: World Bank, 1998; UNFAO, 1999; and authors' calculations.

Figure 1
SADC per capita grain supplies by source, 1963-65 average versus 1993-95 average



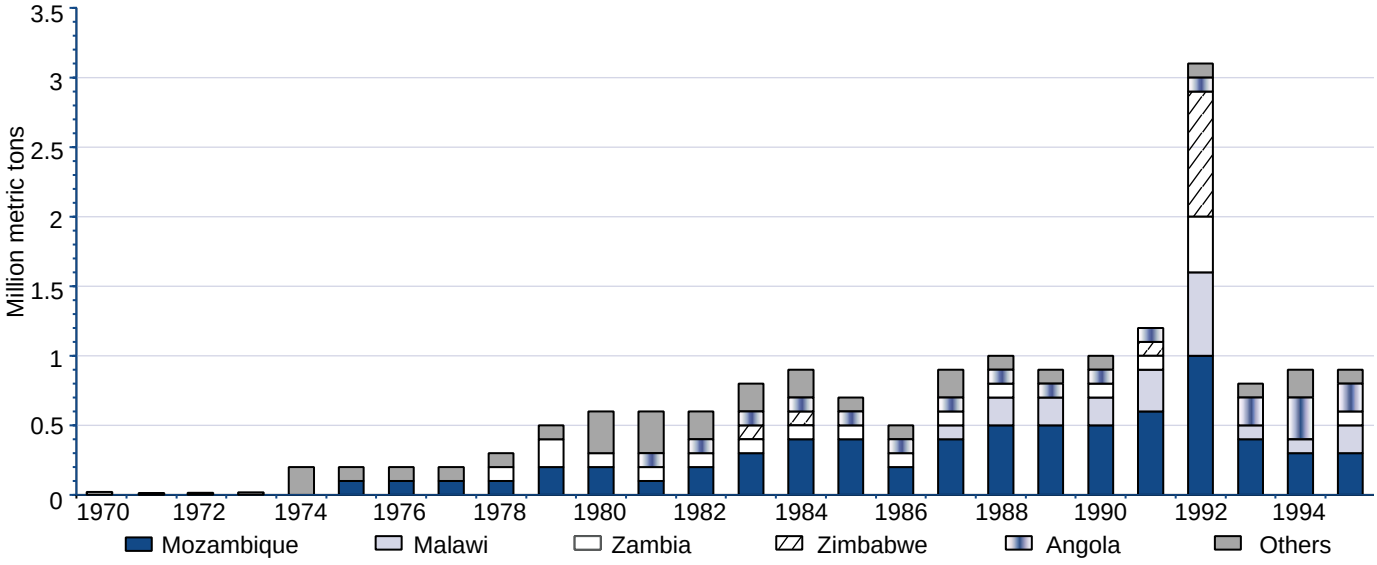
Source: Authors' calculations based on U.S. Dept. of Agriculture, Production, Supply, and Distribution database, 1998.

Table 2—Structure of grain supplies, 1963-65 and 1993-95

Country	1963-65 average				1993-95 average				Coefficient of variation
	Production	Imports[1]	Exports	Supply[2]	Production	Imports	Exports	Supply	1963-95
	Kg/capita								*Number*
Angola	90.7	9.5	24.1	76.1	30.0	47.7	0	77.7	0.26
Botswana	27.1	107.2	0	134.3	33.5	107.1	3.0	137.6	0.70
Lesotho	250.7	19.2	0	269.9	87.0	98.5	0	181.0	0.06
Malawi	203.3	3.3	3.6	202.9	165.0	41.5	0	201.5	0.24
Mauritius	.7	157.3	0.1	157.2	1.8	225.4	19.6	207.6	—
Mozambique	91.7	10.2	0.4	101.5	53.7	27.2	0	80.9	0.23
Namibia	61.6	51.0	0	112.6	53.2	68.3	0	121.6	0.31
South Africa	327.5	15.5	82.5	267.8	292.2	33.9	50.4	271.7	0.31
Swaziland	107.1	23.9	0	131.1	92.2	85.5	0	177.7	0.40
Tanzania	82.9	5.8	1.5	87.2	137.0	6.2	0	142.2	0.51
Zambia	200.8	12.6	0	213.4	148.0	26.9	3.9	172.7	0.37
Zimbabwe	234.0	24.9	.7	258.2	185.2	28.6	24.0	201.8	0.37
SADC	195.5	13.7	40.9	176.3	163.9	49.1	17.2	185.3	0.24

— = Not calculated because of negligible production.
[1] Imports include food aid.
[2] Supply is defined as production plus imports minus exports. Supply figures shown may not match due to 3-year averaging.
Source: U.S. Dept. of Agriculture, Production, Supply, and Distribution database, 1998.

Figure 2
SADC food aid imports by country, 1970-96



Source: FAOSTAT database, 1999.

variation, which measures how far observations are dispersed around an average for a sample.[7] Regionally, the production coefficient of variation over the 1962-95 period was 0.24, although it is as high as 0.51 in Tanzania and 0.70 in Botswana. This means that food supplies tend to be available in either booms or busts, particularly for those countries in the region that depend primarily on domestic production for food supplies. In severe production deficit years, which have occurred regionally about once every decade (most recently in 1991/92), large scale international food aid efforts have been necessary to avoid widespread starvation.

[7] Technically, the coefficient of variation is measured as the ratio of standard deviation to the mean.

Regional Grain Stock Program

Consumption variability is a major concern in several countries. For countries in which domestic production is the primary source of food supplies, buffer stocks are often used to smooth year-to-year food supply variability. It has been hypothesized that if the SADC countries work together on a regional stocking program, they may be able to reduce their own national supply variability. In this section, a regional stocking simulation model is developed to analyze this policy alternative. Countries might be able to exploit the fact that SADC's regional production tends to be less variable than national-level production.

The central idea behind all stocking models is that grain supplies should be stored when grain production is unusually high and pulled out of storage when production is unusually low. The goal is to develop a model in which quantities are stabilized at the country level by storing and releasing stocks at a regional level.

A special feature of this study is that actual historical supply outcomes are contrasted with models of simulated supply outcomes for the same period. These results are meant to be suggestive only. Implementing some of the policies analyzed here may have very well changed the historical behavior of the economic actors in these countries.

In this study, the assumption is made that a regional authority would decide what levels of stocks to store and release. This authority would use the following regional model to determine the appropriate stock levels.

Stage 1:

- Determine regional stocking capacity;
- Calculate the historical trends in production, net imports, and supply in each country;
- Set a uniform policy target for supply (production plus net imports) levels;
- Set rules determining each country's net imports to keep these levels relatively constant;

Stage 2 (for each country and time period):

- Take historical production volumes and calculate model net imports;
- Calculate supply, and determine desired stock changes;
- Determine if sum of desired country stocks exceeds regional capacity, adjust if necessary.

An important assumption is that stocks will be stored in and transported to and from South Africa. This assumption exploits a unique feature of the region: that South Africa has excess capacity of modern storage facilities, which were built up in the apartheid era due to fears of trade embargoes (Lipton, 1986). The South Africa storage assumption essentially means that there is no storage capacity constraint for the regional model. An assumption is also made that stocks cannot fall too low below an arbitrary threshold of 5 percent of the trend regional supply.

The base case of the stocking model sets the supply policy target at 95-105 percent of trend supply levels, consistent with earlier models. When model supplies in each country exceed 105 percent of the supply trend, the grain is stored; when model supplies fall below 95 percent of the trend, grain is removed from storage. As a basis of determining the supply target bounds, the supply trend over time was statistically estimated for each country using "fit-the-best" criterion of different functional forms (linear, quadratic, logarithmic, log-log, and exponential). The net import response functions were estimated for each country individually according to two components: a structural grain deficit reflecting the difference between trend consumption and production. and a transitory component that was statistically modeled to reflect historical import behavior in response to production deviations.[8]

As an example of the stocking model, consider how the program would have worked for a small country like Swaziland in two different years (fig. 3). In 1983, total grain production was severely below the trend at 33,000 metric tons (MT). The model's policy rules call for net imports of 60,000 MT. The total supply for the year would be 93,000 MT, well below the minimum supply target of 149,000 MT (95 percent of trend supply levels). In order to bring the supply level up to this threshold, 56,000 MT would need to be drawn down from the regional stock reserve. The following year, there was a bumper crop of 154,000 MT. The model's

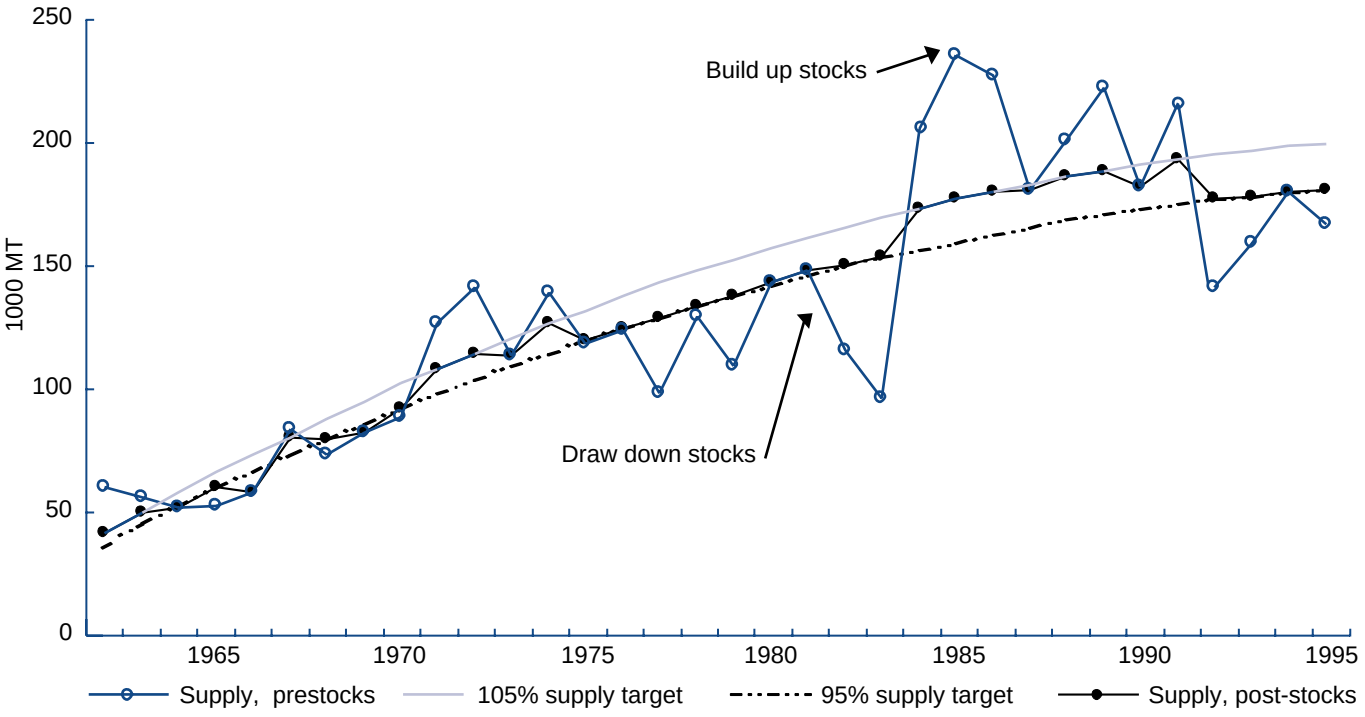
[8] Sensitivity analyses were performed but are not presented in this report due to the primary interest in base case comparability. The stocking model is more sensitive to changes in stock capacity constraints than different supply targets.

policy rules would call for net imports of 46,000 MT.[9] The total supply of 200,000 MT would exceed the maximum supply target of 168,000 MT (105 percent of trend), so that 32,000 MT would go to the regional storage reserve. This example shows how stocks can be used to stabilize supplies—in this case between the range of 95 and 105 percent of the trend supply levels.

[9] Swaziland historically has imported grain, even in bumper crop years. For 1984, trend- or exogenous-level imports would have been 52,000 tons. Transitory differences in import levels were estimated according to a statistical regression (in levels) of import deviations on production deviations; in this case, the beta coefficient was estimated to be -0.159. The transitory component brings total import levels down to 46,000 tons in 1984 due to the surplus (positive) production deviation. Actual imports used in the historical regression were 32,000 tons in 1984.

The stocking program would require fairly frequent interventions in nearly all countries (table 3). In all cases, after the model's stocking actions are taken, the per capita grain supplies are stabilized and are generally smoother. In several of the smaller producing countries, the interventions would be relatively small in terms of volume. However, for the larger producers (Tanzania, Zimbabwe, South Africa), the volume interventions are much larger. In this base model, assuming a starting stock value of 15 percent (1.575 million tons in 1964), stocks average about 10 percent of the region's trend supply and use and range from about 5 percent to about 22 percent over the time period.

Figure 3
Example of Swaziland's model stocking activity



Source: Authors' calculations based on stocking model and U.S. Dept. of Agriculture, Production, Supply, and Distribution database, 1998.

Table 3—Summary of selected country hypothetical stock changes, base case, 1965-95

Year	Angola	Malawi	Mozambique	South Africa	Tanzania	Zambia	Zimbabwe	Region*
				1,000 metric tons				
1965	0	0	0	0	-189	-36	-20	-259
1966	-28	30	0	-351	428	0	0	78
1967	-59	205	0	923	-59	0	172	1,217
1968	-34	243	0	-342	0	17	-81	-203
1969	-48	52	0	-476	-76	19	171	-357
1970	50	98	0	-568	0	0	0	-443
1971	0	-49	0	0	0	0	264	256
1972	-27	0	6	174	158	0	544	848
1973	-2	54	33	-1,420	60	-27	-171	-1,569
1974	40	-139	22	494	-355	85	136	367
1975	56	0	0	0	0	-116	-15	-85
1976	72	57	0	-241	21	0	-107	-156
1977	145	-109	0	0	-9	9	-247	-200
1978	43	0	0	0	-134	15	-80	-177
1979	0	0	0	0	0	0	0	0
1980	38	-12	0	0	45	-56	0	30
1981	47	-92	0	1,052	0	0	397	1,404
1982	-15	-66	-11	0	-73	141	0	-69
1983	-13	-11	0	-900	-56	0	-346	-1,405
1984	0	0	0	0	0	0	0	0
1985	-56	-58	0	0	0	0	398	293
1986	-90	-81	0	0	0	-66	249	-3
1987	-24	-25	0	-34	0	33	-74	-130
1988	-120	0	0	0	-81	157	102	161
1989	-67	85	0	1,318	492	16	0	1,893
1990	-109	0	0	0	0	-59	417	263
1991	0	233	0	0	0	0	151	401
1992	109	-446	-6	-1,161	0	-387	-488	-2,535
1993	25	637	0	0	0	390	316	1,346
1994	0	-2	0	17	-2	0	7	22
1995	83	161	0	-1,332	333	-190	-497	-1,513

*Includes countries not shown.

Source: Authors' calculations based on stocking model and U.S. Dept. of Agriculture, Production, Supply, and Distribution database, 1998.

Regional Grain Import Insurance Program

Grain supplies may be unstable if countries are unable to import the desired or necessary level of grains. This occurs because of a downward domestic production shock, an upward world grain price shock, or a combination of these two events, which leads to prohibitively expensive grain imports. In this section, a regional model is developed to examine the feasibility of creating a new grain import insurance program. A regional grain import insurance program would stabilize aggregate food supplies very differently than a stocking program. With this approach, countries would pay annual premiums according to a predetermined risk profile and then receive occasional compensation whenever import costs exceeded a threshold for a pre-selected consumption target. The risks would be shared in such a way as to facilitate an actuarially sound fund that stays solvent by diversifying risks over the region and over time.

With this approach, it is important to note that import costs can vary according to the interaction of two independent events: country level production deviations and world grain prices.[10] Import costs would not necessarily be significantly above average if, for example, a large production deficit happened to coincide with below-average world prices, or conversely, above-average world grain prices coincided with a large production surplus. The worst possible interaction is for a country to have a severe production deficit (and therefore large import needs) in a year of high world grain prices. To varying degrees, the SADC countries all have been affected over the past few decades by this combination of a production deficit and high international grain prices.

For this approach, we adapted and modified the modeling structure developed by Kondreas, Huddleston, and Ramangkura (1978). The principle of their model remains the same: for each country and each year, determine the food gap (the difference between the average supply level and random production), then determine if the combination of this food gap and international grain prices leads to import costs that are unusually high. When this situation occurs, the country receives financial compensation. Depending on the frequency of occurrence and the level of insurance chosen, each country pays a different premium level.

Again, one would assume that a regional authority would implement a regional program using the model outlined below. The program would be implemented on the basis of historical data.

Stage 1:

- Set the uniform target supply level policy;
- Set the uniform import cost threshold policy;
- Calculate each country's supply trend;
- Calculate each country's import cost trends.

Stage 2 (for each country and each year):

- Calculate the food gap for imports (target supply minus random production);
- Calculate the import costs (food gap multiplied by the world grain price);
- Determine if the model import costs exceed the threshold level:

  If yes, receive compensation in the amount;

  Otherwise, do not receive compensation;

Stage 3:

- Determine each country's risk profile based upon frequency and amounts of compensation;
- Set nonprofit premiums for each country based upon its risk profile;
- Set up a regional risk-pooling fund.

In the base case, the supply target is set at 95 percent of trend supply, while the import cost threshold is set at 110 percent of trend import costs. In order to make comparisons later, we employed the same supply trends used for the stocking model, although the trends are set on a per capita basis. The import cost trends are calculated on a per capita basis using statistical analysis of time trends (fit-the-best criterion).[11]

[10] We assumed that these countries, as relatively small players on the world grain market, do not affect world grain prices. This is a safe assumption with the possible exception of South Africa.

[11] Again, sensitivity analyses were performed, but are not presented in this report. The import insurance model is more sensitive to different supply targets (for example, 90 percent of supply trend) than import cost thresholds (for example, import cost threshold of 130 percent of trend costs).

Table 4—Example of import insurance program for Swaziland

Year	Production	Supply trend=$\hat{S}$	Supply target ($0.95*\hat{S}$)	Import quantity gap[1]	World grain price	Cost of import gap[2]	Import cost trend times 1.1[3]	Compensation formula[4]	Population	Total compensation
	Kg/capita				*$/MT*	*$/capita*			*Mil.*	*$ Mil.*
1980	173	240	228	55	148	8.06	8.64	0	0.607	0
1981	158	239	227	69	122	8.39	8.88	0	.625	0
1982	87	239	227	140	157	21.92	9.12	12.80	.641	8.211
1983	50	237	226	176	145	25.42	9.36	16.06	.661	10.618
1984	226	235	223	(2)	121	(.29)	9.60	0	.682	0
1985	253	232	221	(32)	93	(2.97)	9.84	0	.705	0
1986	225	229	217	(8)	86	(.67)	10.08	0	.728	0
1987	132	222	211	79	119	9.37	10.31	0	.763	0
1988	150	218	207	58	124	7.15	10.55	0	.789	0
1989	170	214	204	34	108	3.67	10.79	0	.814	0

[1] Gap is calculated as per capita supply target minus per capita production. [2] Per capita gap multiplied by world price, divided by 1,000.
[3] Import cost trend determined from historical data. [4] If cost of per capita import gap exceeds trend, calculated difference, otherwise zero.

Source: Authors' calculations based on import insurance model.

Consider how this program might have worked in the case again of Swaziland for the years 1981 and 1982 (table 4). In 1981, per capita production was slightly above average, leading to a relatively normal import quantity gap (69 kg/capita). However, real world prices were below average, so that import costs ($8.39/capita) did not exceed the cost threshold (110 percent of trend, $8.88/capita). However, 1982 was very different. Per capita production was significantly below average (87 kg/capita), leading to a large import quantity food gap (140 kg/capita). In addition, real world prices that year were relatively high at $157/MT. Together, these forces led to a high import bill ($21.92) that was above the threshold level ($9.12/capita). So in this year, Swaziland would have received compensation of $12.80/capita, which, when multiplied by the population leads to total compensation of $8.21 million. These ideas are illustrated for Swaziland in figures 4 and 5.

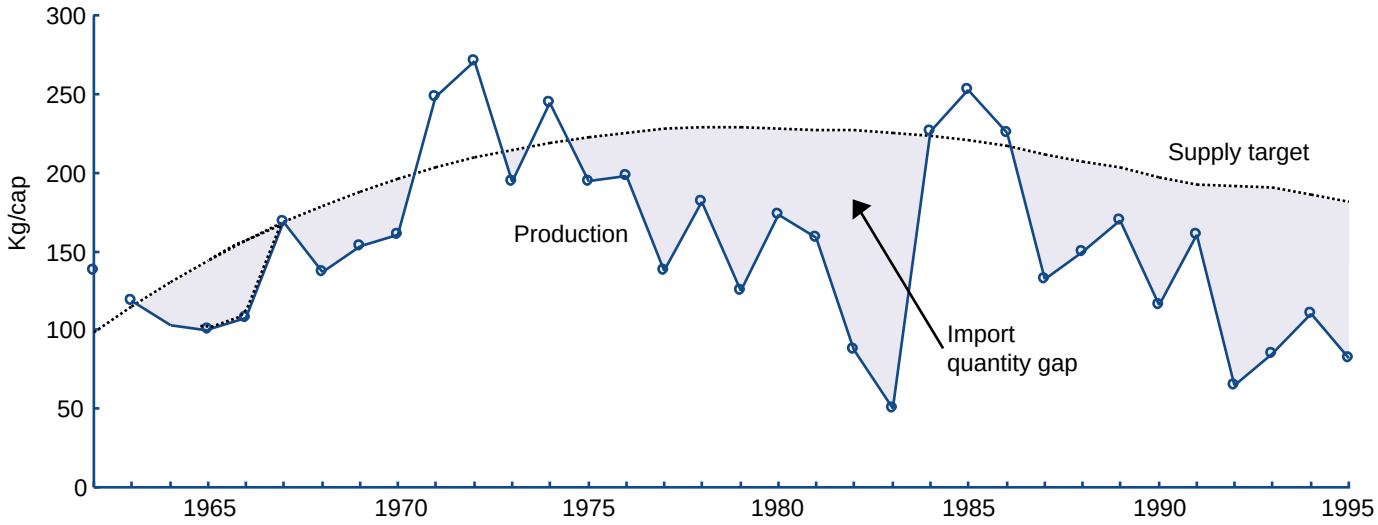
The overall insurance model results are shown in table 5. The largest absolute amounts of compensation in real 1990 U.S. dollars over the 1963-95 period would have gone to South Africa ($1.37 billion, a little over 50 percent of the regional total). This total compensation reflects South Africa's relatively large population compared with its neighbors as well as its occasionally large import needs. However, on a frequency basis, South Africa would have received compensation only 5 times (albeit large amounts) over the 1963-95 period, compared with 13 times for Zimbabwe, 12 for Zambia, and 11 for Swaziland. The average frequency of compensation for all 12 SADC countries was 7.58 times. On a per capita basis, the share of regional compensation differed substantially across countries. Zimbabwe emerges as the largest recipient on a per capita basis, about $85 per person over the 1963-95 period. Next is Swaziland at about $58 per person.

Table 5—Base case results for SADC (cumulative compensation in real 1990 dollars, 1963-95)

Country	Years receiving compensation	Total compensation		Per capita compensation
	Number	*$ Mil.*	*Percent*	*Dollars*
Angola	3	0	0	0.4
Botswana	10	39	1.4	47.1
Lesotho	6	56	2.0	42.7
Malawi	9	168	6.1	26.3
Mauritius	5	24	.9	26.8
Mozambique	5	42	1.5	3.0
Namibia	5	14	.5	10.8
South Africa	5	1,366	49.7	42.6
Swaziland	11	35	1.3	57.7
Tanzania	7	225	8.2	13.6
Zambia	12	220	8.0	35.0
Zimbabwe	13	558	20.3	85.4
SADC	n.a.	2,747	100.0	418.6

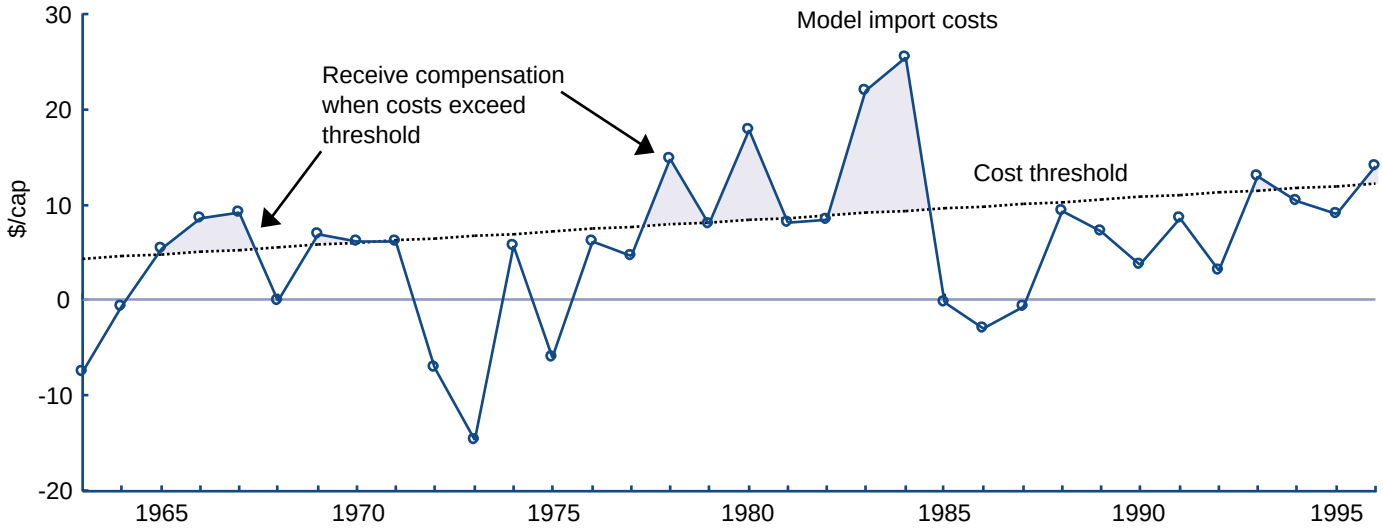
n.a. = Not applicable.
Source: Authors' calculations based on import insurance model.

Figure 4
Swaziland import insurance example: Import quantity gap



Source: Authors' calculations based on import insurance model.

Figure 5
Swaziland import insurance example: Costs of financing import gap



Source: Authors' calculations based on import insurance model.

Botswana, Lesotho, and South Africa have similar levels of about $43-$47 per person.

In order to create an actuarially sound regional fund to handle claims, each country's risk profile would need to be assessed so that annual premiums could be collected. Nonprofit premiums could be calculated by averaging each country's cumulated compensation over the historical period. For example, over the 1963-95 period, Zambia would have received compensation in 12 out of 33 years for a cumulative total of $35 per capita, or about $220 million in total (real 1990 dollars). Averaging that compensation over time, Zambia would have needed to pay in to a fund about $1.06 per person per year. Performing that calculation for each country leads to a regional total of about $11.86 per person per year. This insurance program would need a one-time startup allocation to a fund in order to stay solvent over time, which is discussed later.

Would These Programs Be as Effective as Food Aid in Stabilizing Grain Supplies?

Before answering whether these policy options may be as effective in stabilizing food supplies as food aid, another question needs to be asked first: has food aid been effective in stabilizing food supplies? To answer that question, table 6 shows the standard deviations of per capita grain supplies in each SADC nation with and without food aid. Hypothetically, if food aid imports had been eliminated in the historical period and not compensated in any way (for example, with more commercial imports), supply volatility would have increased in almost all countries.[12] But by how much? Only a few countries show that food aid has had a relatively large impact on stabilizing supplies (measured by reductions in the standard deviations greater than 20 percent): Angola, Malawi, and Mozambique. For other food aid recipient countries, the impact has been generally negligible.

[12] The exceptions are countries (mostly with higher incomes) that have not received food aid in the historical period: Botswana, Namibia, Mauritius, and South Africa.

Table 6—Effects of different policy scenarios on supply stabilization

Country	Status quo (food aid)	No food aid	Insurance	Stocks
	Standard deviation of per capita grain supplies			
Angola	19.4	25.2	16.4	13.7
Botswana	35.1	35.1	28.0	19.1
Lesotho	44.2	47.8	35.2	31.7
Malawi	30.0	39.2	23.2	20.9
Mauritius	13.6	13.6	13.6	13.5
Mozambique	6.3	17.3	6.2	6.0
Namibia	9.6	9.6	8.9	8.8
South Africa	36.8	36.8	27.3	24.3
Swaziland	47.5	52.0	35.8	23.4
Tanzania	31.0	31.4	29.2	28.5
Zambia	40.1	44.0	33.8	32.0
Zimbabwe	61.2	69.9	50.3	39.9

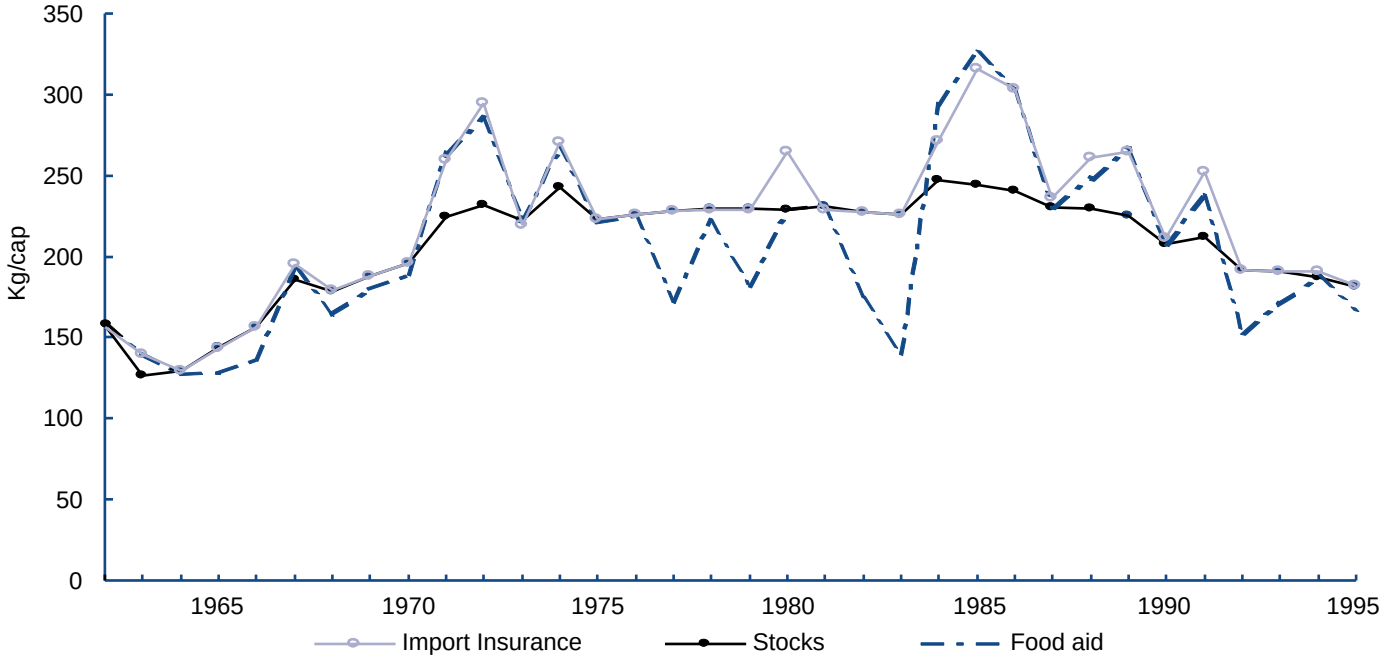
Source: Authors' calculations based on insurance and stocking models.

Compared with the status quo situation with food aid, both the stocking program and import insurance program would reduce supply variability. The stocking program reduces supply variability more than the insurance program since by design it controls both the upside and downside supply risks, whereas the particular insurance program under consideration protects against downside risks only. Both provide a safety net, however. These concepts are illustrated again for the case of Swaziland, where per capita grain supplies for each option were calculated and displayed (fig. 6). For most SADC countries, the differences between the stocks and insurance in terms of per capita supply reductions are relatively small (fig. 7). However, for a few countries like Botswana, Swaziland, and Zimbabwe, the supply reductions are quite significant (compare insurance and stocks data in table 6).

It is important to point out that the stocking and import insurance alternative programs are very different in nature and achieve slightly different goals. The stocking program literally would hold grain stocks in the region whereas the insurance program would make sure that countries could afford to purchase grain on the world market when necessary. The stocking program would hold and release stocks based primarily upon direct physical supply considerations whereas the import insurance program is more administrative and financial in nature, primarily addressing excessive import costs.

Figure 6

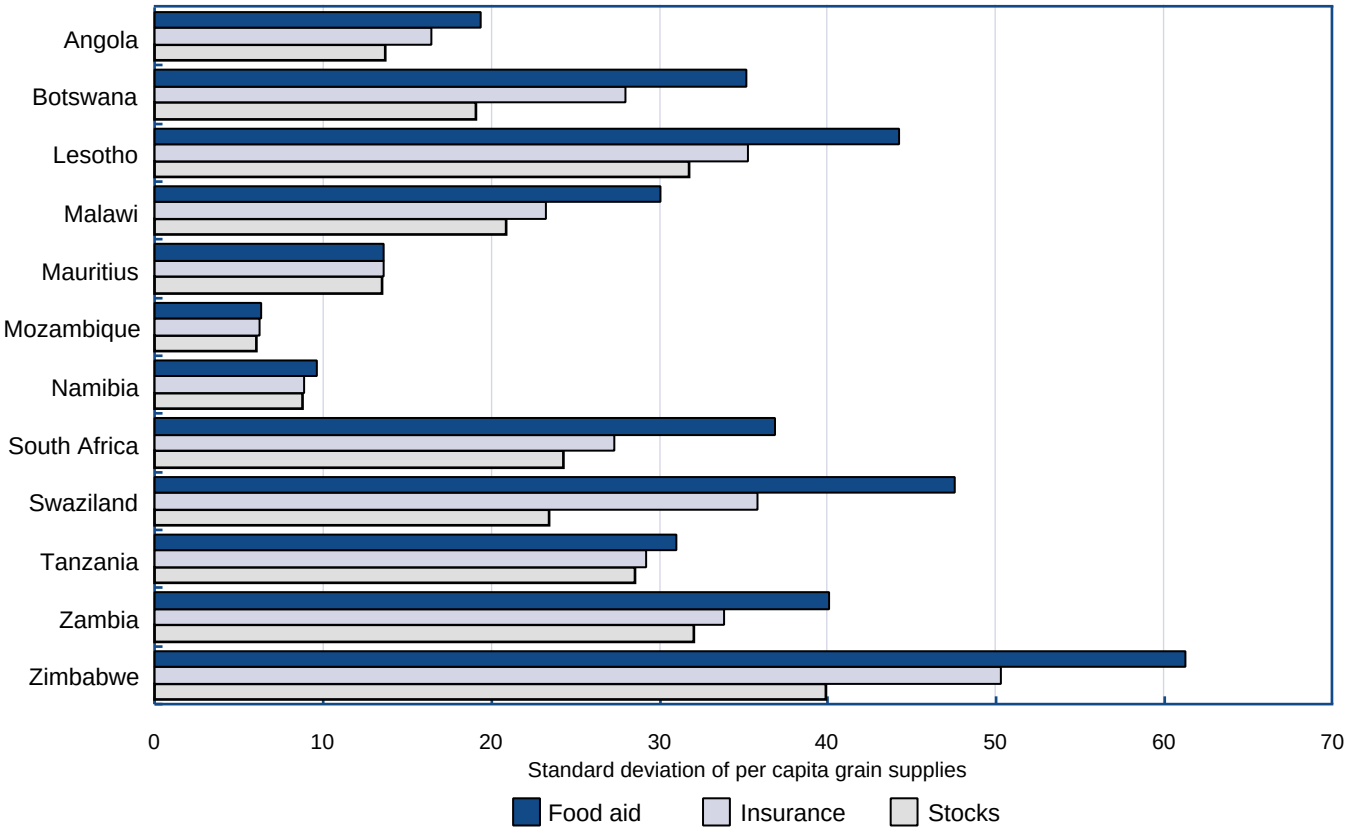
Swaziland per capita supply outcomes under different policy options



Source: Author's calculations based on stocking and import insurance model.

Figure 7

Comparison of policy option stabilization effectiveness 1970-95



Source: Authors' calculations, based on insurance and stocking models.

Would These Programs Be More Cost Effective than Food Aid?

An attempt to answer this question is made primarily from a donor point of view.[13] It is fairly difficult to provide precise estimates for each alternative, so what is provided here are only rough estimates. The historical time period covered in this analysis is 1970-95, for which the data are comparable. The costs of the stocking program option are explored under the assumption that all regional grain stocks would be stored in South Africa, which has excess storage capacity. Data on storage costs were collected from representatives of the South Africa Grain Silo Industry, Ltd., while transportation costs were calculated by estimating the rail or shipping distances and multiplying them by per unit transportation costs published in earlier studies. Based upon this approach and available data, the transportation costs would be nearly twice as much as the storage costs, and the total cost for all SADC countries would be about $1.4 billion for the 1970-95 period. Storage costs can be high when considering new construction costs or the cost of waste and spoilage in inadequate facilities. However, both of these factors are unlikely to be relevant in this case, where there is already excess capacity of modern storage facilities.

For the grain import insurance program, the calculation shows that the insurance program (base case) would have cost about $2.59 billion for all SADC countries during 1970-95 (real 1990 dollars). Depending on the criterion used, a one-time startup fund ranging from $200-$800 million would be needed to keep the pool solvent. Using one criterion (the region's average annual per capita compensation multiplied by initial population), a one-time charge of $580 million would have been needed. This means that the total cost of the insurance program would have been about $3.17 billion. The import insurance program costs could be reduced by using a similar approach with futures prices, such as those now offered in the South African Futures Exchange (SAFEX). Such an approach might be able to take advantage of low international prices with appropriate training on hedging strategies.

To compare the costs of food aid relative to the costs of different options, an assumption is made that food aid volumes would have been replaced by commercial import purchases.[14] Since the majority of cereal food aid is in wheat, we used a weighted world price of wheat (80 percent) and maize (20 percent) to approximate the real price of food aid. The historical volumes of food aid donated to the region in cereals (which is by far the largest component of food aid) are multiplied by this weighted world price. Given these assumptions, food aid expenditures would have totaled about $2.7 billion during 1970-95.

[13] That is, it is assumed that donors would fully pay for the management and operations of all policy options considered. So for instance, with the stocking option, this would include administrative donor overhead costs, silo storage and loading rental costs, and railroad rental costs. Presumably, companies in South Africa charge rates that cover such items as management and depreciation rates.

[14] It is important to note that historical food aid volumes have been donated by several countries and have not been based upon explicit supply stabilization targets such as those of the stocking and import insurance programs considered in this report.

Table 7—Comparison of total costs for different policy options, 1970-95 (base cases)

Country	Food aid	Stocking model	Import insurance model
		Million dollars	
Angola	277	196	0
Botswana	0	7	39
Lesotho	148	16	56
Malawi	291	223	155
Mauritius	0	2	24
Mozambique	1,041	2	42
Namibia	0	2	14
South Africa	0	68	1,366
Swaziland	20	14	31
Tanzania	438	182	184
Zambia	295	119	213
Zimbabwe	192	250	467
Sub-totals	2,702	1,081	2,592
Stock startup	n.a.	330	n.a.
Insurance startup[1]	n.a.	n.a.	580
Total	2,702	1,411	3,172

Note: Data for the import insurance model may be different from those shown in table 5 because of the shorter time period used here.

n.a. = Not applicable.

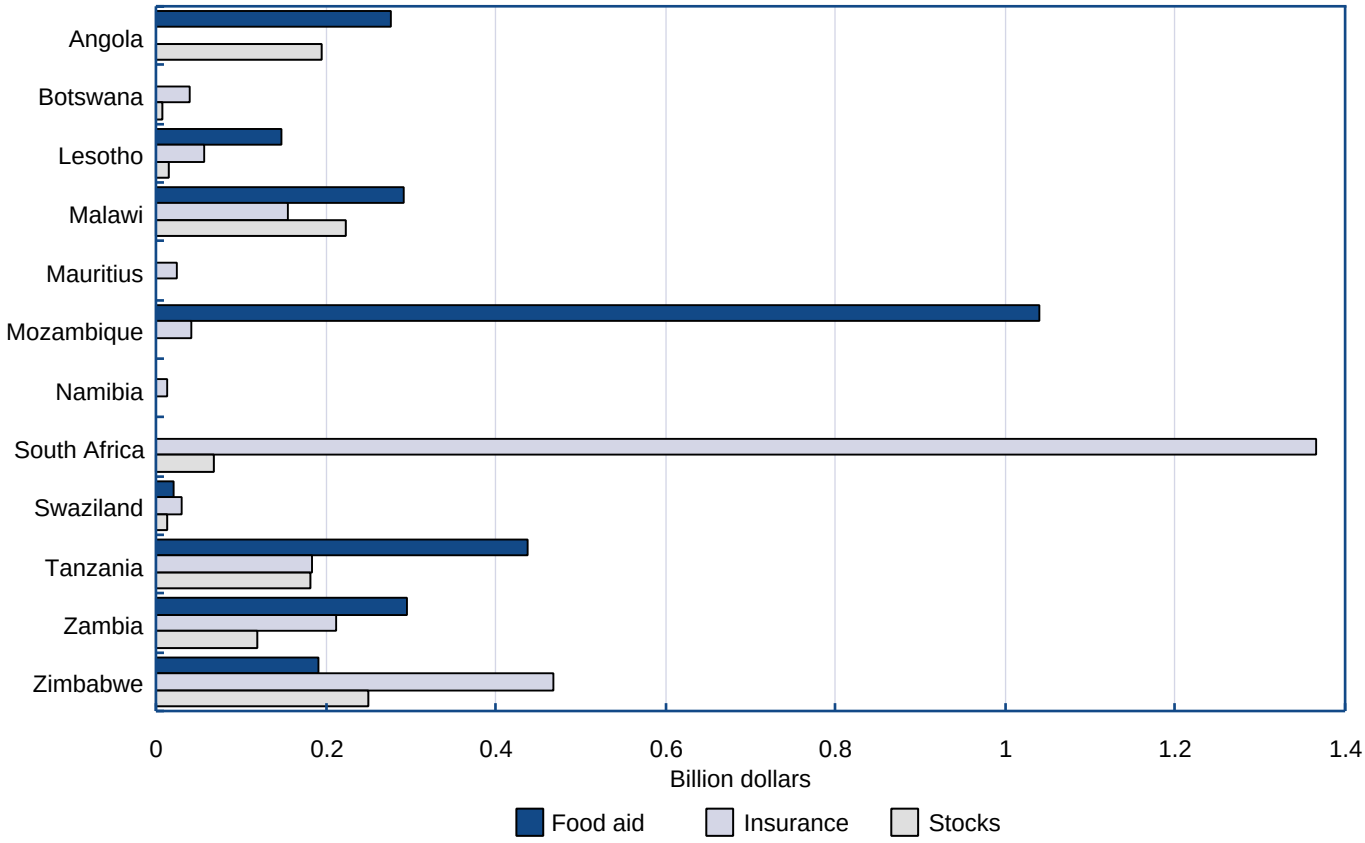
[1] Many different types of criteria could be used to establish a startup insurance fund. The insurance fund could have survived historically with a bare minimum $200 million. See text for further discussion.

Source: Authors' calculations based on the insurance and stocking models.

These results are summarized in table 7 and figure 8. In short, it appears that the stocking program could be less expensive for donors than the costs of food aid as a means of helping the SADC countries achieve stable aggregate food supplies, even if a strong assumption is made that the donors would pay for all of the costs of stocking and insurance. The total cost of the insurance program would vary based on startup costs.

The flip side of the donor cost analysis is examining the benefits for the recipient countries. Currently, under the status quo situation of food aid, Mozambique has been the largest beneficiary by far ($1.04 billion during 1970-95). Under a different program, such as the insurance option, other countries would benefit, notably South Africa ($1.37 billion compared with no benefits with food aid). However, the overall accumulated benefits to South Africa might be misleading because the results are much different on a per capita basis (Zimbabwe and Swaziland gain more over the same period).

Figure 8
Final cost comparison of three regional policy options, 1970-95



Source: Authors' calculations based on stocking and insurance models.

Conclusions

The primary goal of this report has been to examine whether regional policy alternatives to food aid can be more efficient in reducing food supply variation and whether they are cost effective in doing so. We find that the two policy options considered—grain stocking and grain import insurance—would reduce supply variability. The greatest reductions compared to food aid would be achieved with a stocking program, followed closely by import insurance. This report also finds that the grain stocking program would have been less expensive for donor countries than food aid during 1970-95. The cost of the insurance program would depend on startup costs.

Overall, these findings are consistent with earlier studies, such as those by Reutlinger and Bigman (1981), which showed that alternatives to food aid are more effective in stabilizing food supplies in a less costly and more efficient manner. This would seem to suggest that these results are not unique to the SADC countries and may be applicable to other regions as well. On the other hand, it is important to point out that the stocking results may be unique to this region since South Africa built up excess modern storage capacity in the apartheid years. Similar studies of other regions may find the storage program option is not more cost effective when allowing for new capital construction costs.[15]

We did not focus on administrative issues. We did not intend to recommend particular institutions for implementing such policy options, which might detract from the basic findings. However, such issues are potentially very important, especially if institutional and transportation infrastructures are weak in a region. For example, the status quo case of food aid illustrates that despite the best intentions of donors and recipient countries, food aid can have negative effects as has been well documented (for example, slow deliveries that arrive the following growing season, depressing producer prices and incentives in the recipient countries).[16] The grain stock program and import insurance program also might lead to unforeseen consequences and involve hidden costs, such as high administrative costs and depreciation of local infrastructure. It should be noted that this also applies to food aid, which has not been taken into account. Again, it is important to emphasize that these results depend on the assumption of regional peace and cooperation. Other factors can dramatically change the distribution of costs and benefits. This is particularly true in countries where political considerations can easily override economic considerations.

It is important also to think about how to design such programs to minimize undesirable political interference. Previous experience has shown that grain stock programs at the country level tend to be vulnerable to political lobbying, which may lead to an imbalance of producer and consumer considerations. In developing countries that tend to have urban biases, consumer interests might allow prices to go down but exert political pressure whenever they start to go up. For grain import insurance, it is important to point out that it still has not been tried (Sarris, 1998). This policy would seem to be relatively undistorting. Potential problems with insurance might be slow processing of claims or a tendency by governments to underreport output. Reporting issues could be handled by a neutral statistical agency. Claims processing could be handled with effective administrative procedures, such as rapid processing based upon preliminary information followed by later detailed accounting and reconciliation procedures.

So far, countries continue to rely on food aid to reduce the impact of production shortfalls. One could argue that earlier failures to negotiate regional treaties to cooperate in holding stocks have led to the ongoing reliance on food aid as a policy option. Other factors contributing to ongoing reliance on food aid include political realities that need to be addressed. This analysis shows that food aid may not be the best use of economic resources; also, it is increasingly coming under pressure in international trade agreements. Thus, it could be beneficial to implement alternative food security policies such as those examined in this report.

[15] Moreover, storage costs in South Africa, which recently have been substantially below rates in the United States, are likely to rise as the country becomes more integrated with the world economy and as available excess storage space eventually dwindles. On the other hand, the import insurance program costs probably could be reduced with the use of commodity futures, which hasn't really been explored in this report.

[16] For a review of different arguments about the motivation and effectiveness of food aid, see Ruttan (1993).

References

Hay, Roger W., and M. Rukuni. "SADCC Food Security Strategies: Evolution and Role," *World Development,* Vol. 16, 1988, pp. 1013-24.

Kondreas, P., B. Huddleston, and V. Ramangkura. "Food Security: An Insurance Approach," Washington, DC: International Food Policy Research Institute, Research Report #4, 1978.

Lipton, Michael. "Intra-Trade and Food Security in Southern Africa: Production Technology or Marketing Institutions?" Paper presented at an Overseas Development Council Conference,The Political Economy of Southern Africa, Washington, DC, 1986.

Missiaen, Margaret. "South Africa: Ag Reforms in the Face of Drought," *Agricultural Outlook*, U.S. Dept. Agr., Econ. Res. Serv., July 1995, pp. 26-29.

Reutlinger, S., and D. Bigman. "Feasibility, Effectiveness, and Costs of Food Security Alternatives in Developing Countries," in *Food Security for Developing Countries* (ed. Alberto Valdés), Boulder, CO: Westview Press, 1981, pp. 185-212.

Robson, Peter. "Integration in Sub-Saharan Africa," in *Economic Integration Worldwide* (ed. Ali M. El-Agraa), New York: St. Martin's Press, 1997, pp. 348-67.

Ruttan, Vernon (ed.). *Why Food Aid?* Baltimore: Johns Hopkins University Press, 1993.

Sarris, Alexander. "World Cereal Price Instability and a Market Based Scheme for Managing the Risk of Developing Country Cereal Imports," International Agricultural Trade Research Consortium conference paper, Alexandria, VA, June 1998.

Technosynesis. *Regional Food Reserve*. Study commissioned by the EC and prepared for SADCC, 1984.

United Nations Food and Agriculture Organization and the International Maize and Wheat Improvement Center. *White Maize: A Traditional Food Grain in Developing Countries*, Rome, Italy, 1997.

United Nations Food and Agriculture Organization (UNFAO). FAOSTAT database, Rome, Italy, 1999.

U.S. Department of Agriculture. Production, Supply, and Distribution (PSD) database, 1998.

World Bank. *Poverty and Hunger: Issues and Options for Food Security in Developing Countries*, Baltimore: Johns Hopkins University Press, 1986.

World Bank. World Development Indicators 1998, CD-ROM database, Washington, DC, 1998.

ISSUES IN FOOD SECURITY

A new series from ERS

This series unveils a number of short multidisciplinary issue papers that address how food security in the United States and throughout the world is affected by issues like trade liberalization, income distribution, and natural resources.

ERS research shows that more than 800 million people are hungry in 67 lower income countries and even though the number of people affected is expected to decline, the situation may become more severe in the poorer countries. Most of the hungry, ironically, live in rural areas, where food is produced. Food security is dependent on food availability, food access (ability to purchase food), and food utilization that is affected by many factors such as safe water, education, and health. Food insecurity can be either temporary or chronic, and overcoming each requires a different set of strategies. The reasons for food insecurity are many: war, poverty, population growth, inadequate agricultural technology, inappropriate policies, environmental degradation, and poor health.

Noticeably absent from that list, however, is large-scale food scarcity. The growth rate in food production worldwide has surpassed the population growth rate, leading to increased food availability per person. This abundance, however, is distributed unevenly. Many low-income countries, it is true, have difficulty producing adequate supplies of food and are thus food insecure at the national level. But more widespread is inequality in food consumption within countries—the result of uneven purchasing power, which can afflict even the highest income countries such as the United States.

At the World Food Summit in November 1996, 186 countries committed themselves to reducing the number of undernourished people by half by 2015. Donors pledged to provide support, in particular, in the area of technological transfers. The commitment to providing food aid was also reinforced.

Since 1996, some regions/countries have significantly improved their economic performance and food security situation. Several lower income countries in Asia and Latin America are clearly in this group. Sub-Saharan Africa, however, has not seen much progress, nor are the prospects for improvement sanguine. Several forces can alter the situation, for good or bad. On the positive side, new technologies, particularly biotechnology, can increase food availability, which, in turn, can reduce food prices, making food more affordable for the poor. Global trade liberalization is expected to expand market access for the lower income countries and enhance their ability to compete. On the negative side, a decline in quantity and quality of resources can reduce productivity, even in countries that have shown impressive production performance. This multiplicity of forces means a broad range of issues must be considered at the global level if countries—and all their households—are to become and remain food secure.