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by

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by

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April 1996

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1. INTRODUCTION

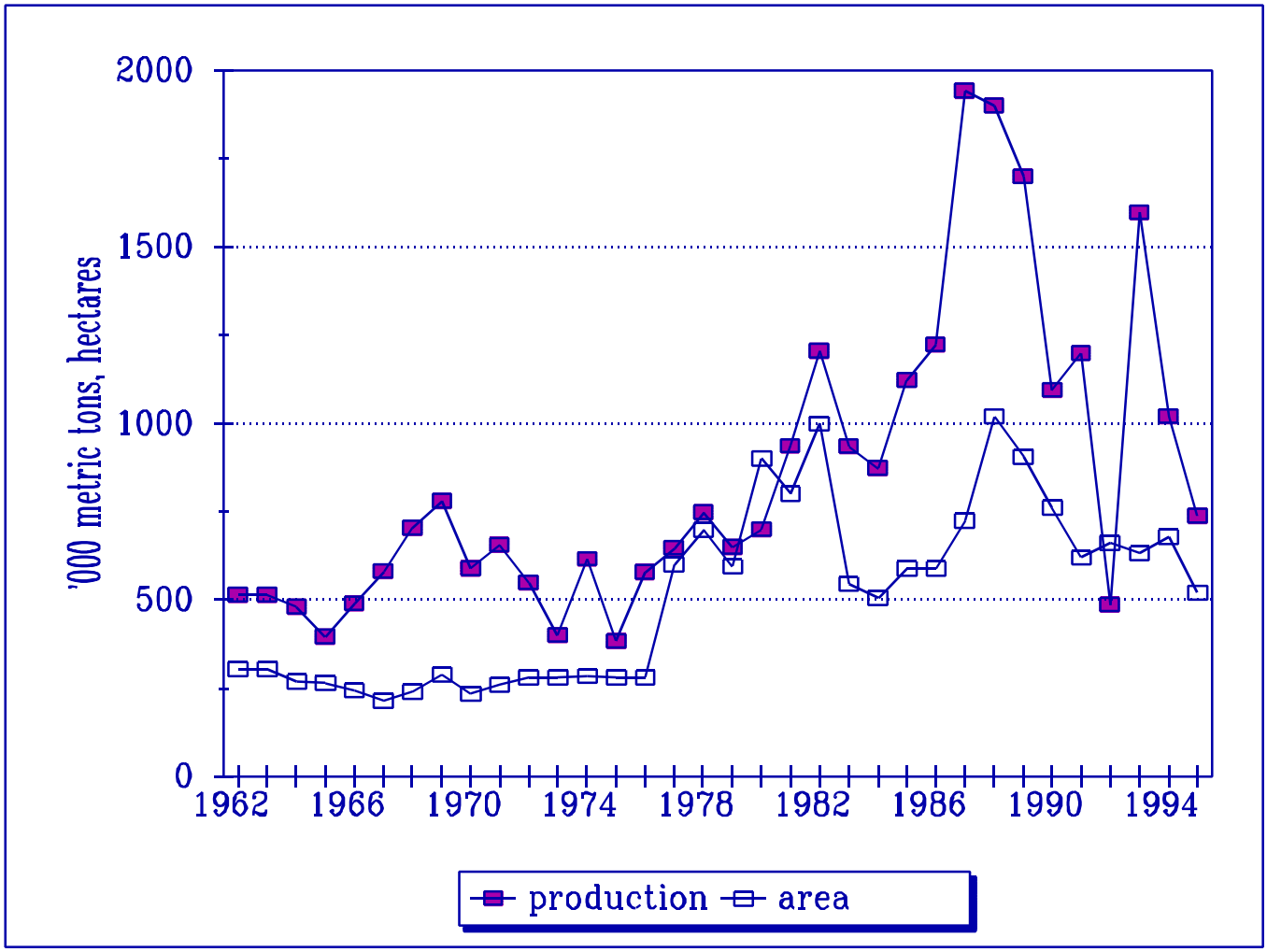
Zambia's agricultural sector is indisputably dominated by maize. Maize is planted on 70 percent of total crop area, and is the main staple for its population of nine million, in both urban and rural areas. Zambians consume more than 170 kilograms of maize per person annually, one of the highest consumption rates in Africa (FAO 1994).

For the past 20 years, Zambia has provided a unique laboratory for examining the impact of institutions and organizations on the development and dissemination of maize technology. Zambian maize production increased nearly fourfold from the early sixties to the late eighties because of a combination of surplus land,[1] new varieties better suited to smallholder conditions, favorable input prices, the physical availability of input and product marketing outlets, and good weather (Figure 1). Increased maize production accelerated the agricultural growth rate to 3.4 percent annually during the 1980s, among the highest rates in sub-Saharan Africa. Government expenditures in support of maize were unsustainable, however, consuming seventeen percent of the total government budget by the late 1980s. Since the late 1980s, the implementation of structural adjustment programs, which liberalized marketing and financial services formerly dominated by the government, has contributed to a decline in maize area and production.

This chapter explores how Zambia's policy and organizational environment has shaped the development, spread, and more recently, the disadoption of maize technology. It also traces the political motivations that drove the establishment of the policy and organizational framework supporting maize production and impeded the efficient operation of the parastatal-managed marketing system. Options facing Zambian policy makers for increasing food production under evolving political and economic conditions are discussed in the light of these experiences.

[1] Only 15% of Zambia's arable land is cultivated.

Figure 1. Maize Production and Area



Sources: 1962-90, USDA
1991-94, CSO and CSO/MAFF
1995, CSO/MAFF estimate

2. THE AGROECOLOGICAL ENVIRONMENT

Zambia is located in the savanna ecological zone, and subdivided into three major agroecological regions. Rainfall varies from under 700 mm annually in the southern Zambezi Valley near the Zimbabwean border in Region I, to over 1400 mm in parts of Northern Province in Region III. Region II's annual rainfall (800-1000 mm), good soils and proximity to Lusaka and the Copperbelt markets make it the most favorable region for maize production. In most years, Regions I, II and III produce about 5, 65 and 30 percent of Zambia's maize, respectively. Region III's proportion has increased during the last several seasons because of drought in Region I and the southern portions of Region II.

In much of southern Africa, including Zambia, colonization introduced modern commercial large-scale farming systems that evolved alongside the traditional small-scale systems. Today, there are three major categories of farmers in Zambia. Smallholders cultivate less than five hectares, use mainly hand hoes and few external inputs, and consume most of their produce. Seventy-five percent of Zambia's 600,000 farm households are small-scale, accounting for more than 60 percent of total cropped area. Medium- (5-20 hectares) and large-scale farmers (over 20 hectares) use improved seeds, fertilizers, animal draft power or tractors, and sell most of their production. Smallholders and medium-scale farmers produce the majority of maize, small grains, groundnuts and cotton. Large-scale farmers produce 60% of wheat, soybean, coffee, milk, high-value horticultural crops, and account for most livestock product sales.

3. THE POLICY AND ORGANIZATIONAL ENVIRONMENT

Three key development pillars, erected during the colonial era, continued to influence Zambian maize policies and production into the 1990s. First, copper's overwhelming dominance in the economy relegated agriculture to a subordinate sector whose primary function was to provide food for mine workers. Second, the state set an early precedent for extensive intervention to achieve policy objectives, the most important of which was to ensure urban food supply through control of prices and market channels. Third, the price stability of maize relative to other crops, assured by the state marketing system, attracted smallholders to maize production.

At independence in 1964, the new Zambian government inherited both a copper fortune and the socioeconomic problems resulting from copper-led development. The government had an urgent need to diversify an economy so heavily dependent on copper exports. Post-independence agricultural policies balanced between often-conflicting objectives. The government's general aim was to increase domestic maize production in order to supply the densely-populated urban mining areas with cheap maize meal. A second objective was to reduce reliance on the European commercial farmers by increasing the participation of African farmers in commercial agriculture, simultaneously raising rural incomes. A third government objective was the improvement of regional equity[2] by increasing market participation by farmers in remote, less agriculturally advanced provinces, especially those in Eastern and Northern Provinces who were key supporters of then-President Kaunda's governing party.

Beginning in the mid-1970s, government policies and organizations created a facilitative environment that drew smallholders into commercial maize production by providing maize technology appropriate for smallholders, price incentives and essential services. Most important were the development of new maize varieties (discussed in the following section), pan-territorial and pan-seasonal pricing enforced through an effective parastatal monopoly on maize marketing, fertilizer subsidies, provision of credit at subsidized interest rates, and the countrywide establishment of local cooperative depots that provided inputs on credit and purchased maize from farmers.

3.1. Maize Marketing

Maize price controls and subsidies to maintain market infrastructure began with the colonial government during World War II. The colonial government's primary objectives were to supply

[2] Agricultural areas adjacent to the railway line bisecting the country have been favored recipients of state investment since the colonial era. The British South Africa Company (BSA) built the railway line extending north from Zimbabwe during the first decade of the 1900s to serve the mining areas in northern Zambia and Zaire's Shaba Province. Through a series of treaties with tribal chiefs, BSA alienated land close to the railway line for European settlement. State agricultural resources in the colonial era were concentrated in these fertile "line of rail" areas in Southern and Central Provinces, since maize produced there could easily be transported to urban markets (Jansen 1977, pp.6-7).

maize to the mining centers while protecting the large white commercial farmers' share of the maize market. The newly independent Zambian government continued to control and subsidize maize marketing, first through the National Agricultural Marketing Board (Namboard) and later the Zambian Cooperative Federation and its member societies. The independent government still wanted to deliver maize to the cities, but also sought to integrate rural smallholders into the commercial maize market. To do so the government subsidized the establishment of marketing services to smallholders throughout the country, and implemented pan-territorial pricing policies that favored smallholders in remote areas over large commercial farmers and others close to the line of rail. Over 60 percent of total maize production was marketed through official marketing channels until the early 1990s. Maize bought by official marketing organizations was resold to parastatal milling companies in urban areas, where it was processed into maize flour and other products that were sold at controlled prices to urban consumers.

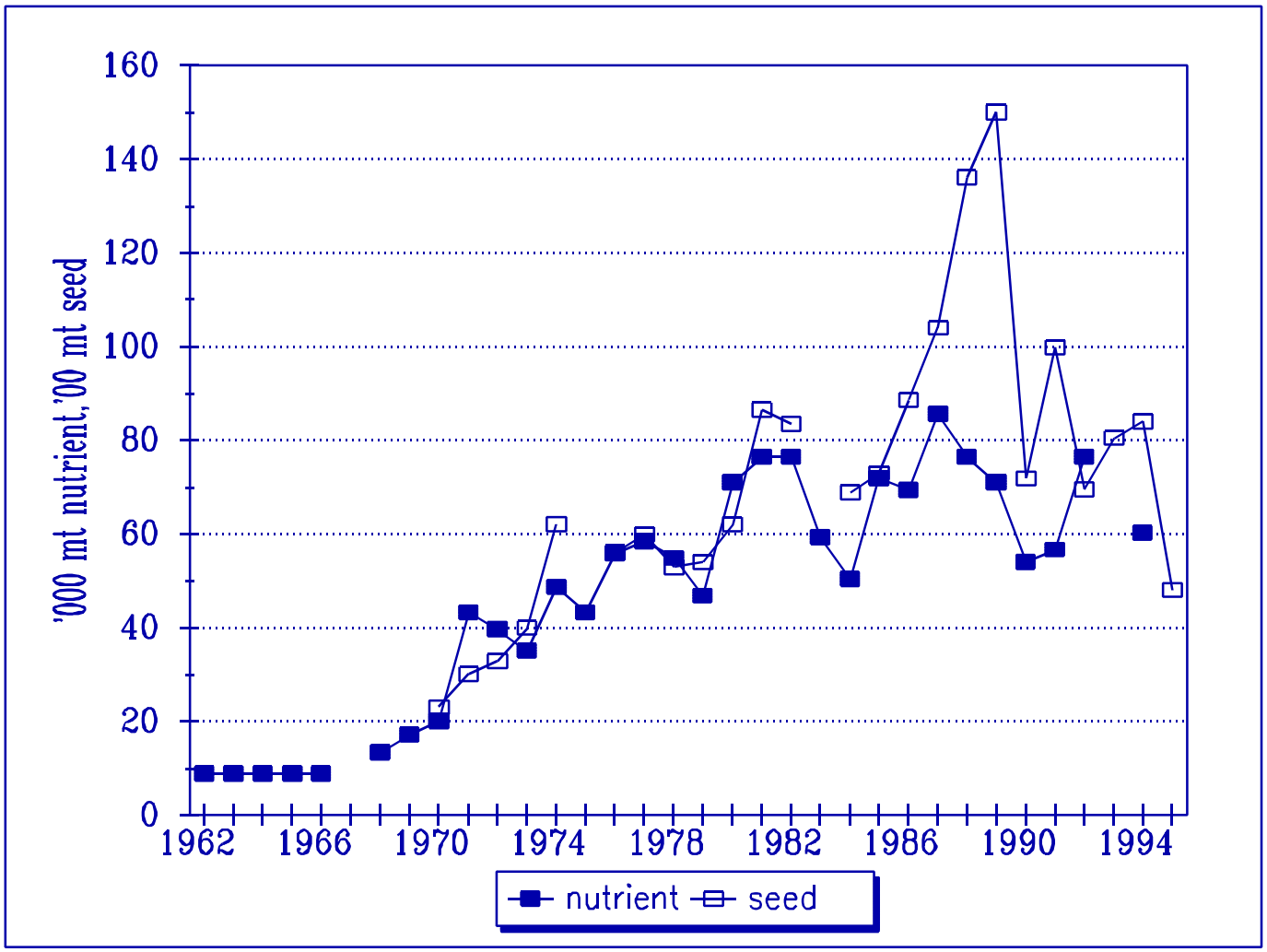
3.2. Fertilizer

Zambia's fertilizer comes from three sources: local production by the Nitrogen Chemicals of Zambia Ltd. (NCZ), commercial imports, and donors. The proportion supplied by each varies depending on the availability of foreign exchange to import fertilizers and donor pledges, but NCZ typically supplied less than one-third of national requirements during the 1980s and early 1990s, operating at half of its design capacity (Williams and Allgood 1991). The government introduced fertilizer subsidies in 1971-72. Initially subsidies were 30 percent of landed cost, but averaged 60 percent by 1982. The maize sector was the main beneficiary of these subsidies; 90 percent of fertilizer is used on maize (Williams and Allgood 1991). As important as the direct subsidies, the expansion of the network of cooperative depots during the early 1970s made inputs more accessible to farmers in remote areas. Fertilizer use expanded from 20,000 - 85,000 tons of nutrient from the early 1970s to the mid-1980s (Figure 2). In the same period, the proportion of total fertilizer consumption in areas outside the line of rail grew from 15 to 39 percent (Sipula 1993).

3.3. Agricultural Credit

The expansion of the cooperative depot system also made it possible for smallholders throughout the country to obtain subsidized credit through government programs. Credit was largely restricted to maize inputs; 90 percent of total smallholder credit was granted for seasonal maize inputs. By contrast, large commercial farmers could secure short, medium, and long-term credit for a variety of enterprises through private commercial banks. The smallholder credit system was coordinated with the maize marketing structure. Groups of smallholders received credit in the form of maize inputs, and signed agreements authorizing the local cooperative depot to deduct the repayment from the sale of their harvest. About one-quarter of small and medium farm households received loans each year until the early 1990s (GRZ 1991).

Figure 2. Fertilizer and Improved Maize Seed Sales



Sources: Seed: 1971-81, Ministry of Agriculture, Food and Fisheries, cited in Rusike 1995; 1982-94, Zamseed; 1995, CSO/MAFF 1995 and personal communication, Muliokela 1995)
Fertilizer: Estimated total fertilizer nutrient applied to maize is 90% of total consumed in Zambia (Williams and Allgood 1991); 1962-79, FAO Fertilizer Yearbook; 1980-88, GRZ 1989 1989; 1989-92 FAO Fertilizer Yearbook; 1994, CSO/MAFF 1995)

4. THE DEVELOPMENT OF MAIZE RESEARCH CAPABILITY AND IMPROVED MAIZE VARIETIES

4.1. Availability of Technology Before Independence

Before independence, Zambia relied on its federation partner Zimbabwe for maize varieties. Zimbabwe had a maize breeding program as early as 1932, resulting in the spectacularly successful SR52 in 1960. SR52 was widely adopted throughout Southern Africa and remains a major influence on maize germplasm in the region. In Zambia, large-scale European commercial farmers were the primary users of varieties and hybrids imported from Zimbabwe. The introduction of SR52 doubled commercial farmer yields, from 1.3 tons/ha in 1949-53, to 2.7 tons/ha by 1959-63 (Makings 1966).

Smallholders, who could not plant on time, used the earlier maturing "local" maize. Zambian "locals" are open-pollinated, usually flinty varieties. Locals required lower levels of management than the early imported hybrids and open-pollinateds,[3] but they are also lower yielding, averaging 1-1.5 tons/ha. Smallholders also began to try SR52, often mixing the hybrid with local seed. In subsequent seasons, they commonly replanted advanced generations of the hybrids instead of purchasing new seed each year. The decline in maize yields through the 1970s (Figure 3) reflects poorer weather conditions, but also the shift in maize production from large farmers to smallholders.[4]

4.2. The Early Zambian Maize Breeding Program

Zambia's maize breeding program was initiated in 1962 at Mt. Makulu Research Station[5] with the arrival of J.B. Abington, who was funded by British aid. Another British-supported agronomist/breeder replaced him in 1973. The first Zambian joined the program in 1976; he was joined by a second Zambian and a Yugoslav breeder in 1978, followed by other expatriates and Zambians. Beginning in the early 1980s, Zambians were sent abroad for graduate training through various donor aid programs. The first Zambian breeder obtained a Ph.D. in 1988.

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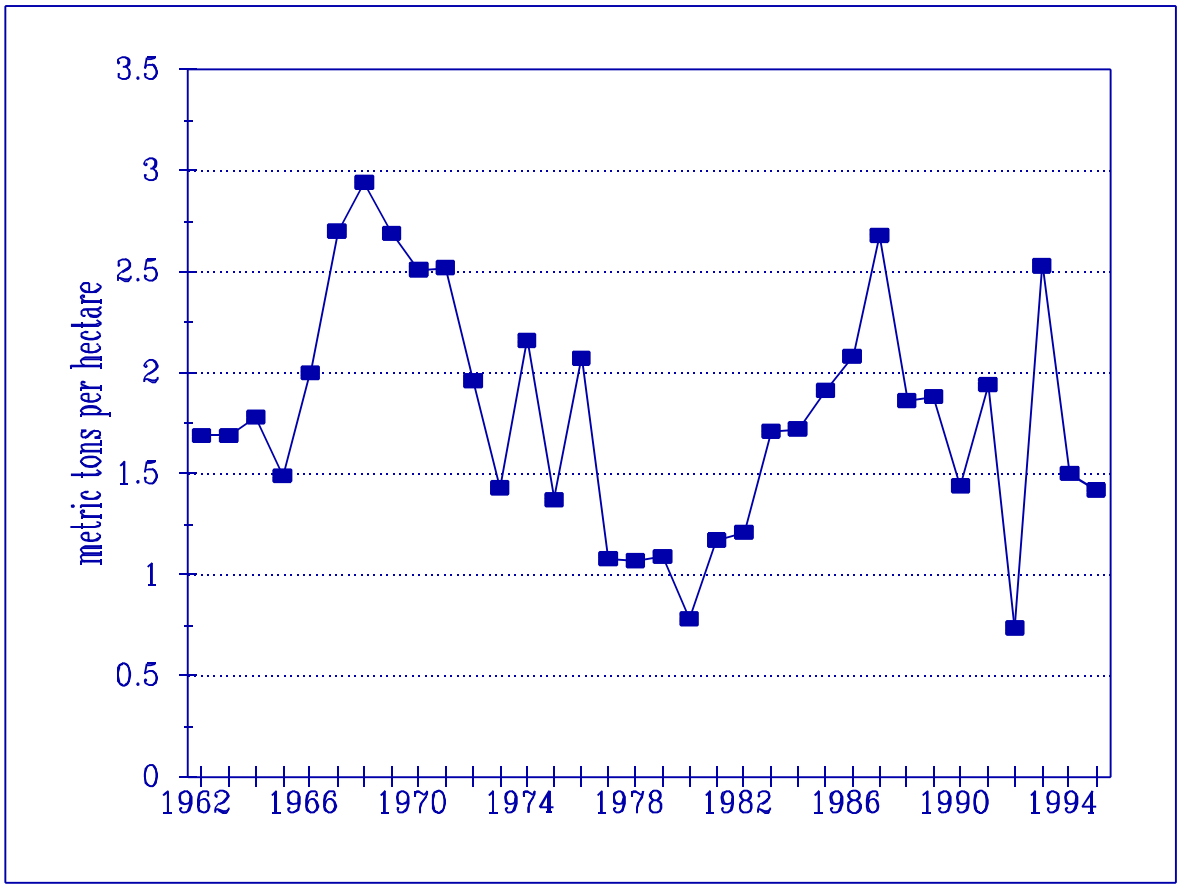
[3] This is less true of the hybrids developed in the mid-1980s and later. The newer hybrids have shorter seasons, and therefore can be planted later, and there is increasing evidence that the hybrids can out yield locals even without fertilizer (Productive Farming, Oct. 1995). Over time, the distinction between "importeds" and "locals" has blurred as maize in smallholders' fields became cross-pollinated with improved maize from neighboring commercial farmers, especially Hickory King.

[4] During the 1970s and 1980s, the small-and medium-scale share of production rose from 60 to 80 percent (GRZ 1990, 34).

[5] It was later relocated to Golden Valley Research Station.

Figure 3. Maize Yield



Sources: 1962-90, USDA
1991-94, CSO and CSO/MAFF
1995, CSO/MAFF estimate

The early focus of the maize breeding program was varietal evaluation. Mass selection started in 1962; following the breakup of the Federation, varieties from Zimbabwe were no longer available. Inbred line development began and breeding for short-season varieties was initiated in 1965, then discontinued two seasons later. The following year, breeding for specialty traits (e.g., sterility, dwarfness, opaqueness) and a population improvement program was begun. In 1970 a three-way hybrid (ZH1) was released, as well as two composites, ZYC and ZSC. All had fairly long growing seasons, and their yields were inferior to SR52.

4.3. Open-pollinated vs. Hybrid Varieties

The most serious problem confronting smallholders interested in planting SR52 was its long growing period that necessitated early planting. Two factors constrained Zambian smallholders from planting SR52 on time. First, it is extremely difficult to prepare the fields with hand hoes before the first rains have softened the very hard surface. Second, if farmers hoe early in the season, a second weeding is required later at the time of peak demand for labor in other crops. For these reasons, farmers usually wait to plant commercial maize until after local maize and other family subsistence crops have been planted, but this carries a high cost. Late planted maize is vulnerable to maize streak virus, especially in wetter areas such has Region III. In general, researchers estimate that farmers lose 1-2 percent of maize yield for each day of delay. Smallholders required maize seed with a shorter season that was better adapted to conditions in the different agroecological regions. In the late 1970s, a key question was the suitability of short-season open-pollinated varieties vs. short-season hybrids for smallholders.

CIMMYT (International Center for Maize and Wheat Improvement) has actively assisted the development of the Zambian maize program since the early seventies, when collaboration with the British agronomist/breeder Bradwell began. Until the mid-eighties, CIMMYT's maize improvement strategy (in Zambia and elsewhere) focused on population improvement and the development of open-pollinated rather than hybrid varieties. Hybrids were considered inappropriate for smallholders, because it was assumed they would be unable to purchase new seed every season, or afford fertilizer and the higher level of labor input required to achieve the yield potential of hybrids.

In Zambia, however, a special set of conditions combined to create an environment that facilitated the adoption of SR52 by smallholders, then made further development and adoption of improved hybrids possible. First, as early as the 1950s, extension programs were already promoting improved open-pollinated varieties such as (imported) Hickory King. During the early 1980s, the extension service's Lima Program[6] focused on the adoption of SR52 and fertilizer packages.

[6] The Lima (meaning to hoe or cultivate) Program was introduced to make it easier for smallholders to understand and apply fertilizer recommendations in combination with improved varieties. One lima represented one-quarter of a hectare. The system was designed so that farmers could apply one to two standard bags of fertilizer to one

Through these early programs smallholders learned about the yield advantage possible through the use of hybrids with fertilizer instead of local or imported open-pollinated varieties. SR52 was estimated to have a 46 percent yield advantage over the improved open-pollinated variety Southern Cross in Zimbabwe (Eicher 1995).

Second, the expansion of parastatal marketing outlets and credit programs made it easier for smallholders to obtain purchased inputs and market surplus maize. The institution of pan-seasonal pricing policies also motivated farmers to market it at local depots immediately after harvest, instead of storing commercial maize on-farm. Most smallholders adopting improved maize continued to grow flintier, weevil-resistant local varieties for home storage and consumption. They did not have to worry about the increased vulnerability of the denty hybrids to insect attack in storage; these concerns were transferred to the parastatal marketing board and its agents.

Third, the leader of Zambia's maize breeding program in the 1970s and 1980s, D. Ristanovic, through his graduate education in the U.S. and work as a senior breeder in the Yugoslav Maize Research Institute, was focused on improvement of hybrid maize, convinced that the real opportunities for yield improvement lay in hybrids, not open-pollinated varieties, even for smallholders.

Fourth, at the beginning of the 1980s the Swedish International Development Authority (SIDA) started to fund maize research and simultaneously helped to establish a seed industry. A parastatal seed company, Zamseed, was organized in 1981. Maize represented 70-90 percent of the total volume of Zamseed's sales, and 60 percent of revenue in the late 1980s; maize seed sales grew from 2000 to 15,000 tons between 1970 and 1989 (Figure 2). To ensure the new company's viability, Zamseed and its technical advisers pushed for the development of hybrids, for which new seed would be purchased each year, rather than open-pollinated varieties whose seed could be saved on-farm and replanted.

4.4. Development and Release of Varieties 1977-94

As a result of investments made in the maize breeding program by the Zambian government, Swedish and U.S. aid programs, CIMMYT and FAO, ten hybrids and two open-pollinated varieties were developed and released between 1977-94 (Table 1). The shorter season length and disease resistance of these new varieties made it possible and less risky for many smallholders to adopt improved maize, especially those outside the established maize-growing areas of Region II.

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lima depending on the formulation. Extension agents distributed packages including a 25-meter rope marked at meter intervals to aid crop spacing, and a 500 gram beaker to measure fertilizer. Crop memos suggesting appropriate fertilizer application levels in terms of the rope and beaker system were developed for each province (McPhillips and Wood 1990).

The characteristics of the new hybrids addressed several issues of the open-pollinated vs. hybrid debate. First, most of the new varieties had shorter seasons than SR52 by as much as seven weeks. Smallholders could plant them later, after the start of the rains or after sowing other crops, and still get good yields. Second, in all but the most adverse environments, hybrid maize out yielded local (and improved) open-pollinated varieties, even without fertilizer (Gibson, personal communication, October 1993; Productive Farming, Oct. 1995). Third, unlike the single crosses SR52 and MM752, several new hybrids were double or three-way crosses, which meant that their yields were more stable if farmers planted second generation seed (although this was never recommended)[7]. Finally, on the question of affordability of hybrid seed, the yield in seed production from three-way crosses was as much as three times higher than from single crosses. The higher the seed yield, the lower the cost of producing maize seed. These savings could be passed along to the farmer as cheaper seed.

Two open-pollinated varieties were also released in 1984, MMV400 and MMV600. MMV400 was developed as an extremely fast maturing, drought-tolerant variety suitable for low-rainfall areas. Its flinty kernel made it more resistant to weevil infestation in storage. MMV600 is a medium long-maturing, streak-virus resistant variety. Although a possible niche existed in the commercial market, it was difficult to motivate farmers to use open-pollinated varieties after they had tried hybrids with fertilizer and achieved impressive yield gains. As long as inputs were available locally through government programs, farmers took the chance with hybrids; and usually their credit packages tied them to cooperative-delivered input packages. The unanticipated success associated with improved open-pollinateds to date has been MMV400's growing popularity as an early food source (green maize) during the hungry period between January and April.

[7] The average yield loss when SR52 seed was replanted was about 33-43 percent, but for advanced generations of MM603/604 it was only 15-20 percent (Norrby 1986; Gibson and Ristanovic 1985).

Table 1. Characteristics of Zambian maize hybrids and varieties

Name and year released	Days to maturity	Potential Yield in tons/ha[a]	Target region	Characteristics
MM501 1984	130-135	6.0	I, II	Single cross, white semi-dent; drought tolerant; mod. resistant maize streak virus (MSV), rust, blight, cob rot
MM502 1984	140-145	7.5	II, III	Single cross, white semi-dent; multiple cobs; high resistance MSV; mod. res. blight, cob rot
MM504 1984	135-140	6.5	I	Three-way cross, white dent; drought tolerance; good resistance lodging; mod.res. MSV, rust, blight, cob rot
MM601 1984	140-145	7.5	II, III	Single cross, white semi-dent; mod.drought tolerance; resistance blight, rust, MSV, cob rot
MM603/604 1984	145-150	7.0	II, III	Three-way cross, white dent; multiple cobs; high resistance MSV, resistance blight, rust, cob rot
MM752 1984	160-165	8.0	II, III	Single cross, white dent; susceptible lodging, MSV; mod.resistant rust, blight
MM612 1988	155-160	7.0	II, III	Double cross, white dent; resistant MSV
MMV600 1984	150-160	4.0-5.0	I, II, III	Open-pollinated, white flint; resistant lodging, rust, blight, MSV
MMV400 1984	120-125	2.5-3.5	I	Open-pollinated, white flint; resistant blight
MM441 1992	115-120	5.0	I, II	Double cross, white dent; drought tolerant, moderate resistance MSV
MM62 1992	145-150	7.0	II, III	Modified single cross, yellow dent; moderate tolerance blight, cob rot, MSV

Sources: Zamseed Maize Production Guide 1991; GRZ Guide to Commercial Crop Production 1990; D. Ristanovic, personal communication, 1992

[a] Research station yields under medium levels of management.

5. ADOPTION AND IMPACT OF IMPROVED ZAMBIAN MAIZE VARIETIES 1984-92

5.1. Adoption

SR52 was widely adopted by large farmers in Zambia, but only about 30 percent of smallholder area was ever planted to SR52 or its advanced generations (Howard 1994, Kumar 1994). Adoption of the new improved Zambian maize varieties by small and medium-scale farmers was rapid and extensive following their introduction in 1984, however (Figure 4). Yields of Zambian improved hybrids have an estimated 60 and 20 percent yield advantage over locals and SR52, respectively. Results of a survey of 462 small- and medium-scale farmers in the principal maize-growing areas indicate that by 1988-89, almost half the total small/medium maize area was planted to Zambian improved varieties, climbing to 60 percent by 1991-92 (Howard 1994). Adoption rates differed dramatically between regions: farmers planted improved maize on almost three-quarters of maize area in Region II, the main maize belt, but on less than a quarter of dry Region I maize area, and on about 40 percent of area in high-rainfall Region III.

Access to resources distinguished adopters from non-adopters. Improved maize adopters had larger farms, more labor (larger households), a higher level of formal education, were more likely to use animal traction or farm machinery, and tended to live close to service centers and major roads (Howard 1994). Investments in agricultural services also had a striking impact on smallholder adopters. Nearly all improved maize adopters, 88 percent of small and 97 percent of medium farmers, had used fertilizer in at least one season, and fertilizer application rates for maize were the second highest in Africa in the late 1980s (CIMMYT 1990). In addition, 64 and 90 percent of small and medium farmers sold maize; 42 and 68 percent had received credit for maize, and 47 and 58 percent of small and medium farmers had been visited by an extension agent. The dependence of these farmers on local, as opposed to regional, depots is an indication of how widespread and localized service provision became throughout Zambia's maize-growing areas. Eighty-two percent of improved maize users obtained their fertilizer at local depots, 86 percent sold their maize there, and 80 percent purchased maize seed locally (Howard 1994).

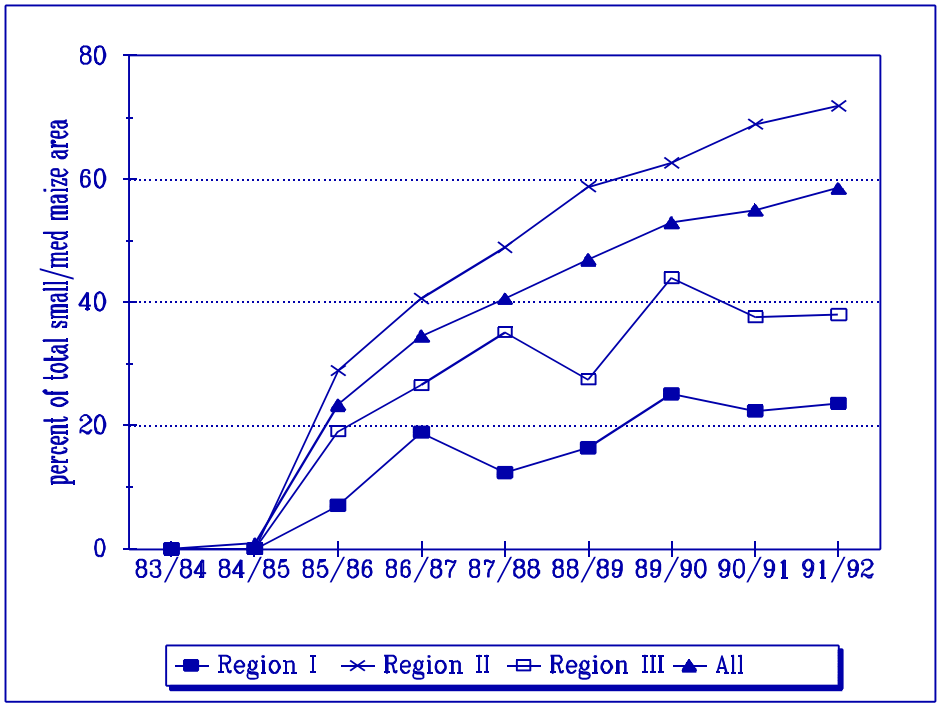
This adoption of improved maize varieties and fertilizer in Zambia is impressive by any standard. Malawi is agroecologically similar but has never had more than one-quarter of aggregate maize area sown to improved hybrids or open-pollinated varieties (Smale 1995). In Eastern and Southern Africa (excluding South Africa), only Zimbabwe and Kenya have higher adoption rates (CIMMYT 1994).

5.2. Average Rate of Return to Maize Research and Development

The sustained adoption of improved maize technology by Zambian smallholders, particularly those in remote areas, was clearly linked to concurrent investments in the seed industry, extension service, and marketing policies/organizations. Therefore, the costs of these complementary

investments were estimated and included in an analysis of the economic rate of return to the package of maize investments.[8] In spite of the widespread adoption of Zambian improved maize varieties, the average rate of return (ARR) on all investments in the maize industry was negative for the 1978-91 period (Table 2). However, extending the analysis period to 2001 resulted in a favorable ARR of 42 percent. The critical difference is the assumption that GRZ expenditures on marketing drop sharply after 1992, when government support of maize and input marketing largely ended. When marketing costs are excluded entirely from the calculation, the rates of return are sharply positive, over 100 percent for both the 1978-91 and 1978-2001 periods. This implies that in the 1978-91 period, the cost of additional investments in marketing (representing nearly 60 percent of total maize industry costs) made the entire maize investment package uneconomic (Howard 1994).

Figure 4. Small/Medium Farmer Adoption of Zambian Improved Maize Varieties and Hybrids



Source: Howard 1994 N.B. Region I has an annual rainfall of less than 800 mm; Region II receives between 800-1000 mm, and Region III receives over 1000 mm.
N.B. Region I has an annual rainfall of less than 800 mm; Region II receives between 800-1000mm, and Region III receives over 1000 mm.

[8] These costs, and the average proportion of total cost represented by each for the period 1978-91, were: additional production costs associated with the new technology (33.7%), maize-related costs of research (2.3%), extension (3.9%), seed industry (1.3%) and marketing (58.9%).

Table 2. Economic Rate of Return (ARR) to Investments in Maize Development

	Economic rate of return	
	1978-91	1978-2001
	(percent)	
Including all costs (additional production, research, extension, seed, marketing costs)	negative	42.1
Without input/marketing subsidies, assuming 25% of area planted to improved maize in the with-subsidy case continues to be planted in the absence of subsidies	65	77
Without input/marketing subsidies, assuming 50% of area planted to improved maize in the with-subsidy case continues to be planted in the absence of subsidies	68	85
Without input/marketing subsidies, assuming 75% of area planted to improved maize in the with-subsidy case continues to be planted in the absence of subsidies	84	96

Source: Howard 1994

Since the cost of marketing subsidies was pivotal, numerical simulation was used to project what might have happened to production, technology adoption, distribution of benefits, and the ARR in the absence of maize price controls and marketing subsidies, for a representative year (Table 2). The results of the simulation showed that (1) if the new Zambian maize varieties had not been available, and if price controls and marketing subsidies had not been in effect in 1987-88, the estimated total production of maize would have been 15 percent lower than actual production; and (2) if the new Zambian maize varieties had been available, but with no price controls and marketing subsidies in place, aggregate national production would have been from three percent lower to 14 percent higher than actual production.[9] In other words, the main impact of the price controls and marketing subsidies was to redistribute production, and discourage it in some areas, not to increase aggregate production.

[9] Depending on assumptions about the maize area farmers would plant with improved varieties and technology in the absence of maize price controls and marketing subsidies. The low case assumes that small/medium farmers would plant at least 25 percent of the area that they planted to improved maize in the actual 1987-88 case; the high case assumes they would plant 50 percent of the area.

The major impact of the marketing subsidies and price controls was to shift maize production from large to small farmers, and from areas adjacent to the line of rail to more remote and drier regions. Large farmers produced about 20 percent, and small/medium farmers 80 percent of total maize in the actual 1987-88 case. With the new technology but without price controls, large farmers would have produced more than a third of the total. Price controls and the overvalued exchange rate kept maize prices far below border levels (Figure 5), discouraging production in areas close to the line of rail with established market access. Guaranteed prices and markets for maize accelerated production in more remote areas where farmers had few if any commercial crop alternatives. In the absence of price controls and market subsidies, areas close to the line of rail would have produced 72 percent of total maize production, instead of 51 percent, their actual share in 1987-88.

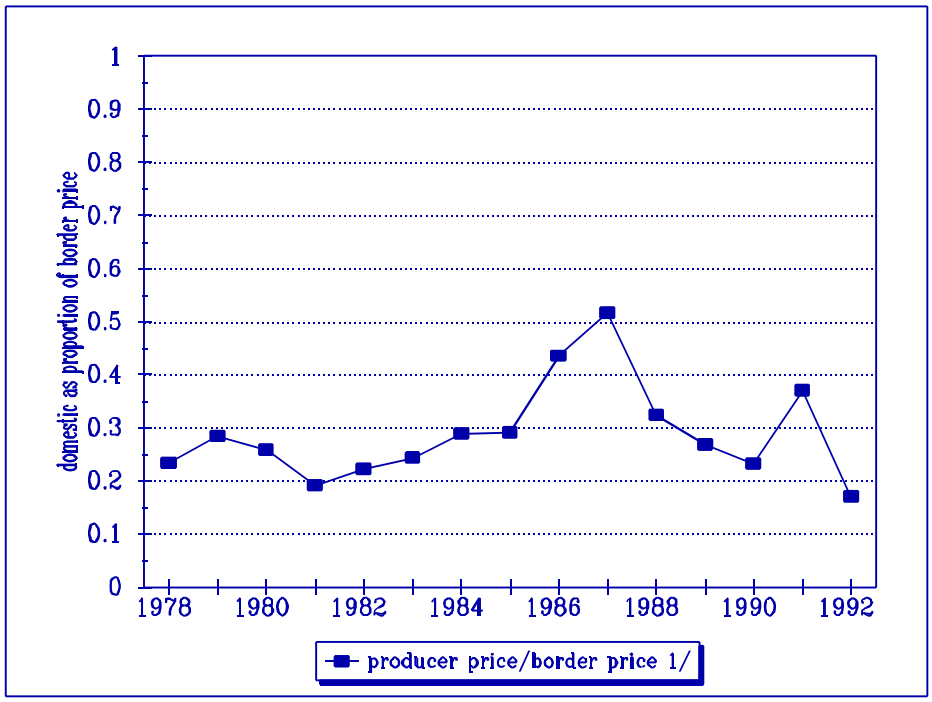


Figure 5. Ratio of Domestic Maize Producer Price to Border Price

Source: CSO, Howard 1994

1/ Since Zambia was a net maize importer in most years between 1978-92, the border price is equivalent to the import parity price for this period. In most years, Zimbabwe has been the principal supplier of imported maize to Zambia. The FOB price at the point of export from the Zimbabwean depot closest to the Zimbabwe/Zambia border is used as the basis for calculation and converted to Zambian kwacha using a shadow exchange rate (Howard 1994). The shadow exchange rate adjusts for the overvaluation of the kwacha reflected in the official exchange rate.

Transport and handling costs from the Zimbabwean depot to the Zambian border are added to arrive at a border price. The domestic maize producer price is the pan-territorial price set by the Zambian government.

The implementation of maize price controls caused large losses of economic surplus for large farmers in Central and Southern Provinces, but small farmers gained from the controls and subsidized market system, especially those in remote areas. However, economic surplus gains by urban consumers from the total package of maize investments, including heavily subsidized maize meal prices in urban areas, dwarfed economic surplus gains by small producers.[10]

Retail prices paid by consumers for maize meal were as little as 40 percent of import parity in the early 1970s. These policies encouraged rural and urban consumers to replace traditional foods such as sorghum and millet with maize meal. Maize consumption rose from an average of 145 kgs to 170 kgs per person between the 1970s and the late 1980s (FAO 1994).

[10] Urban consumer surplus in the actual case was almost ZK 839 million, compared to total producer surplus of **negative** ZK 61 million. The primary reason for loss of producer surplus was that producer prices were set below import parity levels for farmers in the major maize-producing areas of Region II (Howard 1994).

6. THE POLITICAL ECONOMY OF MAIZE INVESTMENTS

For farmers, the total cost of production is the sum of transformation (e.g., converting seed, fertilizer and labor inputs into maize production on the farm) and transaction costs (e.g., acquiring the inputs, taking the produce to market) (North 1990). Early public investments in infrastructure fundamentally changed transformation and transaction costs for farmers (mostly large-scale) along the line of rail. Implementation of marketing/input programs by the newly independent government beginning in the 1970s was an attempt to similarly reduce transformation/transaction costs for smallholders away from the line of rail, who had benefited little from colonial mining-centered development.

Maize development programs played an important role in solidifying political support for Kaunda's governing party, UNIP. Kaunda's supporters were urban dwellers and those who had been excluded from economic development during the colonial period, e.g., in Northern and Eastern Provinces. Beginning in the late 1960s, UNIP's popularity began to shrink. The establishment of pan-territorial pricing, subsidized fertilizer and country-wide marketing services was a way of strengthening support for the party in remote areas, with the effect of taxing farmers along the line of rail, who were mostly settler commercial farmers or Zambians who had supported a UNIP rival, the ANC. Maintenance of low consumer prices for maize was essential for continued urban voter support. However, the cost of these maize subsidies proved fiscally unsustainable.

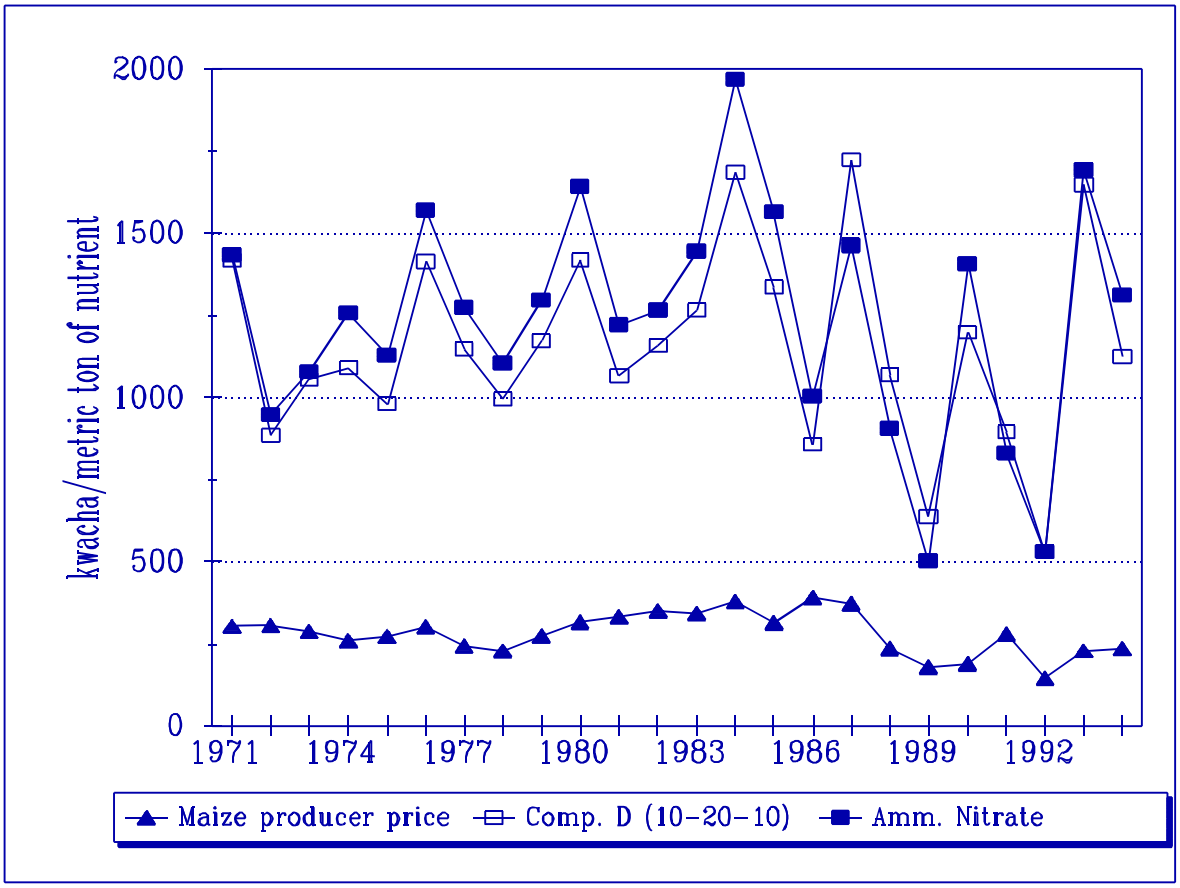
Government efforts to increase the marketable surplus of remote smallholders suffered from three major flaws. First, the exclusive focus on maize, and the pan-territorial pricing structure for maize and maize inputs, facilitated a shift in the geographic pattern of maize production that was uneconomic. The guaranteed prices for maize and maize inputs were very attractive to farmers in remote areas where commodity markets were thin, but the cost of transporting inputs and maize over these long distances, borne by the government, increased the maize subsidy. In these areas, strengthening market services for more valuable crops such as food and grain legumes, tobacco, cotton or coffee might have been more sustainable. In contrast to the remote farmers, farmers close to the line of rail, especially large farmers, were discouraged by producer prices set far below border levels (Figure 6), and many switched to non-controlled commodities like wheat, soybean, poultry and cattle production for the domestic market, since the overvalued kwacha discouraged production of export crops. Food security in drought-prone areas was affected because farmers partially substituted maize for more drought-tolerant crops such as cassava, millet and sorghum. Pan-seasonal pricing also motivated farmers to sell crops immediately after harvest, instead of storing on-farm and selling at intervals. This greatly overtaxed the buying, transport and storage facilities of government marketing agencies.

Second, the maize policies, and the absence of incentives for the agents implementing the policies (Namboard, the cooperatives, mills, lending institutions) to keep costs low, led to inefficiencies in the marketing system and did not facilitate an evolution toward a mixed public-private finance and marketing structure for a broader array of commodities. Maize policies did not allow marketing

organizations to have profit margins. In some years, both the producer price and the into-mill price of maize were set at the same level or the maize producer price exceeded the maize into-mill price. The transportation and handling costs of maize incurred by the agents, along with other parts of the price differential, were reimbursed by the government as subsidies after the season. Both providers and beneficiaries of maize marketing and input services came to regard the services as political largesse. Underweight bags were common in rural maize buying, many crop receipt vouchers were fraudulently issued, and the politicization of maize made it difficult for state banks to deny farmers new credit even after defaults (Howard 1994, Scott 1995).

Third, as its base of support continued to contract, UNIP banned its main political rival, making Zambia a single-party state. With this move, UNIP isolated itself from groups representing key economic interests in Zambia, especially those in the private sector. This affected maize policy-making in two ways. Groups who were directly tied to private industry, business, and medium-to-large-scale agricultural production lost the platform through which they could debate and publicize the negative impact government policies in general were having on the private sector, in particular the great cost of the maize programs and their effect on commercial maize production in the line of rail areas (Bates and Collier 1993).

Figure 6. Real Maize Producer and Fertilizer Prices



Source: GRZ 1990b. 1993-95. 1985=100.

7. THE TRANSITION TO LIBERALIZED MARKETS

By the mid-1980s, it was obvious that the government-controlled system of maize marketing and consumer subsidies was draining the Treasury. Skyrocketing marketing board costs and consumer price subsidies were the primary factor, and the resulting problems snowballed through the system. Marketing agencies paid producers late, resulting in their subsequent inability to pay loans on time. Liquidity problems for the credit and input agencies led to late procurement and delivery of inputs (Howard 1994).

The World Bank, IMF and donor agencies began to promote agricultural market reforms at this time, conditioning future loans on the implementation of reforms that promoted both liberalization (the removal of regulatory restrictions on the private sector) and privatization (the withdrawal of the state from direct marketing functions) (Jayne et al. 1996). Price controls were removed on all commodities with the exception of maize meal, and some restrictions on foreign exchange, imports and exports were lifted. Because maize represented a "social contract" between the UNIP government and Zambian citizens, however, it was difficult for Kaunda to implement maize market reforms in anything but a piecemeal, start-and-stop fashion. Meal price increases sparked urban riots in both 1986 and 1990.

The pace of structural adjustment gained momentum with the election of Frederick Chiluba to the presidency in late 1991. Chiluba, a former Copperbelt labor leader, made maize system reform a key part of his political platform during the 1991 presidential campaign. Shortly after taking office, Chiluba accelerated and expanded the reform process begun by the Kaunda government, removing import and export restrictions, completely liberalizing the foreign exchange market, and reducing the size of the civil service. Implementation of the most challenging item on the reform agenda, maize sector reform, was delayed by the severe 1991-92 drought, which greatly reduced crop yields. Following the drought, the reform process has been plagued with problems due to inconsistent policy formulation and implementation by the government, and to the collision between maize market reforms and reform impacts from other sectors, especially finance.

7.1. Fertilizer and Seed Market Reforms

Real fertilizer prices varied substantially from 1970-95 (Figure 6), partly because of the government policy of keeping nominal prices constant for two years in a row (GRZ 1990). In 1988, the government ceased direct price subsidies for fertilizer, but continued to support transportation costs until 1993. Since the removal of fertilizer price subsidies in 1988, the fertilizer: maize price ratio has generally increased, i.e., it has become more expensive in "maize terms" for farmers to buy fertilizer. Fertilizer was cheapest in these terms in the mid-1980s, at the height of the maize production boom. In 1986, the ratio of fertilizer nutrient to maize producer price was 2.4. By 1993 and 1994, it had increased to 7.3 and 5.2.

The seed industry had been partially liberalized by 1996. The cooperative systems's continuing liquidity problems led the parastatal Zamseed to diversify its seed distribution in the early 1990s from an exclusive relationship with the provincial cooperative unions to a mix of private dealers and direct sales through Zamseed-owned outlets and credit organizations (Rusike 1995). The passage of the Investment Act in 1991, which provided legal protection and tax incentives for new investments, motivated the entry of four multinational seed companies, including Pioneer Hi-Bred International, Cargill, Pannar, and Carnia, but Zamseed continues to control 90 percent of the market (Rusike 1995, GRZ 1995). Other seed regulation changes had a detrimental effect on seed market privatization, however, including the introduction of compulsory seed certification, which required all new varieties and hybrids to be officially released through the government before they could be sold in the country, and the requirement that seed companies submit their parent lines to the Zambian Seed Control and Certification Institute for testing (Rusike 1995).

7.2. Maize Marketing from 1991-95

The Chiluba government began to reduce meal subsidies and issue licenses to private traders in late 1991, but these actions were overtaken by the need to begin a large food procurement and distribution program involving both donated and commercial supplies. The government announced a "floor" price (which quickly became recognized as an official price) and appointed government purchasing agents to buy domestically produced maize. Into-mill and consumer prices were also set by the state.

Normal rains returned in 1992-93; farmers increased their maize area and reaped an excellent harvest, over 1.6 million tons. To fill the apparent vacuum in the market, and to increase the rate of credit repayment, the government appointed several rural financial institutions and a cooperative union as buying agents for maize and several other crops. These agents contracted local sub-agents. The government's actions created confusion and distrust among private traders, who saw the appointed agents as a screen for continued government involvement in marketing.

At the same time, the government lifted controls on interest rates and simultaneously tightened the money supply to curb inflation. Interest rates rose from 50 to 120 percent over four months. As a result, many commercial farmers exceeded their overdraft agreements and avoided bankruptcy only through negotiated debt rescheduling measures with the banks. The crop marketing system broke down as buying agents misused funds and the government was unable to maintain the floor price. Instead of cash or checks, many farmers were issued promissory notes which were not redeemable for 6-12 months. Domestic wheat and maize markets were further disrupted by the late arrival of food aid, and export crop producers were affected by the sharply appreciating kwacha. The difficulty of competing with traders receiving government financing, a stronger kwacha which discouraged maize exports, and escalating interest rates dampened the interest of the private sector in buying, storing and marketing maize (Scott 1995, GRZ 1995). Farmers were caught between rising input and financial costs, lower producer prices, and an incomplete marketing system.

Producers entered the 1993-94 season with severe liquidity problems – unpaid debts, unsold commodities, and unredeemed promissory notes – that delayed maize plantings. The confusion over marketing arrangements continued. On one hand, the government announced the total decontrol of maize producer prices and elimination of transport subsidies, but at the same time referred to floor prices. Politicians sought to allay consumer fears about rising prices by unofficially announcing into-mill grain prices. Again, private trading activity was limited as traders lost confidence that the government would refrain from intervening in the market in a way that would undercut their ability to function profitably. Although the government's stated intention was to end the buying agent system, it continued to provide credit to the rural financial institutions and use cooperative unions as buying agents to help collect loans from farmers. Still, private trading activity increased, and regional and seasonal differentiation of maize prices began to develop, but the government continued to effectively set floor and into-mill prices, and finance marketing agents until 1994-95 (GRZ 1995).

The 1994-95 season was the first in which the government refrained from announcing any prices or and the private sector played a dominant role in input and commodity marketing. Nearly full regional and seasonal differentiation of maize and other crop prices occurred, based on market conditions and marketing costs. Real maize prices have fluctuated since 1992-93 but began to recover in 1994-95. Private sector confidence rose with the consistent messages from the government about non-intervention, and the introduction of a marketing credit revolving fund. The government also began leasing many of its storage warehouses to private traders and transporters.

The 1994-95 season also marked the first time the government provided no funds to the traditional state lending institutions. A marketing credit revolving fund was established to encourage commercial banks involvement in maize market credit delivery, but participation was limited mainly because of inadequate funding from the government budget (GRZ 1995).

8. MAIZE SUPPLY RESPONSE DURING LIBERALIZATION

Total area cultivated in Zambia has declined by 10 percent since 1990-91, and by more than 15% from the 1985-90 average (GRZ 1989, 1995). Much of the decline is due to a reduction in area under maize, in response to poorer weather, lower producer and higher input prices, declining access to credit, and uncertain market conditions. Maize area represented 70 percent of total crop area in the mid-1980s, but had declined to 58 percent by 1994-95. The area planted to most other major crops is near the late 1980s average, and there have been substantial increases in area of groundnuts, millet and mixed beans (CSO 1995). The decline in maize area is most pronounced in the drier and more remote regions, areas where panterritorial pricing and marketing support encouraged maize expansion beginning in the 1970s. An apparent shift by smallholders from maize to sorghum, millet and groundnuts in Southern and Western Provinces is emerging, and, in Eastern Province, a shift from maize to higher-value crops such as groundnuts and cotton. Groundnut area is also increasing in the far north.

The liberalization of foreign exchange markets has removed the bias against agricultural exports, and since 1992, agricultural exports, primarily by large-scale farmers and agribusinesses, have more than doubled in value and become more diversified. Sugar, cut flowers and specialty horticulture exports have grown very rapidly.

Input use has stagnated or declined in the past few seasons, largely due to the contraction in credit (Figure 2). Fertilizer use, which peaked in 1986-87 at nearly 85,000 mt, declined to 60,000 mt in 1994-95 (CSO/MAFF 1995). Maize seed sales also declined, from 15,000 mt in 1989-90 mt in 1992-93 to less than 5,000 mt in 1994-95 (CIMMYT 1993, CSO/MAFF 1995 and Muliokela, personal communication, 1995). Studies conducted by Adaptive Research Planning Teams (ARPT) in Western, Northern and Eastern Provinces confirm that fewer inputs are available to smallholders in remote areas post-liberalization (Tembo 1994). Private dealers faced with poor transport conditions and high market costs were unwilling to deliver inputs to remote areas, and key inputs were readily available only in district centers (Bangwe 1995).

New organizational arrangements are also emerging to fill the gap left by the withdrawal of state services and the collapse of many cooperatives. The development of networks of large and small, localized traders has proceeded rapidly in some regions. In the traditional line of rail provinces, Central and Southern, some large commercial farmers have established businesses to supply inputs, crop marketing and processing functions for area farmers. Similar businesses have also grown up in Eastern Province, which has a relatively high population density and a long-established Asian/Zambian business community. The development of trading networks has been much slower in provinces such as Northern and Western, which have lower population densities, weaker infrastructure and little tradition of trading. The persistent agricultural service vacuum in these areas has heightened the impact of the withdrawal of panterritorial pricing and guaranteed government markets for maize, leading many smallholders to revert to subsistence agriculture.

During the last several years, a variety of private contracting arrangements have also emerged to facilitate input provision, commodity production and trade. These have been as simple as bartering arrangement in which a dealer agrees to provide fertilizer in exchange for future delivery of a specified quantity of maize. More sophisticated out grower schemes for tobacco (Burley Tobacco Growers Association), cotton (Lonrho) and a private exporter of paprika have pre-financed crops or provided inputs, advisory services and crop collection and marketing. Contract enforcement in these schemes has been problematic, however, and several have broken down.

9. CONCLUSIONS

9.1. The Politics and Impact of Maize Investments

Zambia's maize experience represents an important case for Africa, because it has the potential to significantly increase its agricultural production through both area expansion and intensification. Following independence in 1964, the government of Zambia and donor organizations invested heavily in creating an enabling environment for the expansion of smallholder maize production. The policies had both production and political objectives. These aimed at (1) increasing domestic maize production in order to supply Lusaka and the mining belt with cheap maize meal; (2) reducing reliance on the European commercial farmers, and raising rural incomes, by increasing the participation of African farmers in commercial agriculture; and (3) improving rural equity by increasing the market involvement of farmers in more remote, less agriculturally advanced provinces, especially those in Eastern and Northern Provinces who were key supporters of President Kaunda's UNIP party.

The research and extension services successfully developed and disseminated improved maize varieties to smallholders. The government provided important motivators for technology adoption by smallholders, including direct price subsidies on fertilizer, pan-territorial pricing of fertilizer, seeds and maize itself, and, perhaps most important, the provision of local credit, input and marketing facilities through cooperatives. The synergy between technology, policies and good weather increased national maize production by nearly 400 percent from 1964 to 1988, and the agricultural growth rate accelerated to 3.4 percent annually during the 1980s, among the highest rates in sub-Saharan Africa.

The policies worked, but it was a qualified success. The government's enforcement of pan-territorial prices well below border levels led commercial producers along the line of rail to shift away from maize production to less controlled crops. The controlled prices and guaranteed markets were much more attractive to farmers in remote areas who had few if any alternative commercial opportunities. But the costs to government of subsidizing transport costs and other parts of marketing system in these areas escalated swiftly during the 1980s. A calculation of the ARR for the total package of maize investments from 1978-91 (including research, extension, additional production costs, seed industry and marketing costs) showed that, even though adoption of new maize technology was high, approaching 60 percent of total maize area, the ARR was negative because of the oppressively high marketing costs borne by the state.

The fast uptake of maize hybrids by smallholders and rapid expansion of maize area and production in the 1980s demonstrated Zambia's potential as a maize "porridge bowl" for southern Africa. Key elements were the development of appropriate technology and the dramatic reduction of uncertainty for smallholders in terms of maize price stability, and credit, fertilizer, seed and market availability. However, the way the UNIP government reduced uncertainty, through price controls, input subsidies, and the direct provision of services, encouraged commercial maize production in areas where it was uneconomic and eventually overwhelmed the treasury in the late

1980s.. The entitlement status of maize programs made reforms of any kind difficult for the Kaunda government, and facilitated opportunistic behavior by cooperative officials and farmers with loans from financial institutions that has slowed the process of liberalization and privatization.

9.2. The Painful Process of Reform

The process of agricultural sector reforms, begun in the late 1980s and intensifying after 1992, has been extended and rocky, with varying impacts. Maize production and area, and total crop area and production, have fallen significantly from the levels of the mid-1980s, partly because of less favorable weather conditions, but also as a result of the pervasive uncertainty about input and product markets – by farmers and traders alike – following the start-and-stop government withdrawal from marketing. Maize production is declining fastest in the more remote areas, where farmers are returning to cultivation of traditional subsistence crops such as millet, sorghum and beans.

10. POLICY IMPLICATIONS FOR NARS AND AGRICULTURAL PLANNERS

10.1. What Influences Technology Adoption? Who are the Clients of Agricultural Research?

In Zambia, the successful adoption of new maize technology by target smallholder groups was dependent on concurrent investments in complementary organizations that promoted marketing of inputs and maize to smallholders, even in remote areas. This is still the case as private replaces public investment. This implies that researchers and policy makers, in setting priorities for technology research and evaluating the probability of a technology's success, need to recognize the systemic nature of constraints to technology utilization. Failure to adopt may not simply indicate a technical problem on the farmer's field, but could be linked to unavailability of credit, inputs, markets, or incompatibility of the commodity with the preferences of consumers or industrial users.

In the past, planning for technology development has tended to isolate technology issues from the broader agricultural sector. However, the ability to target the most important constraint areas where new technology is needed, recognize the non-research barriers to technology adoption, and assess whether or not these are binding, requires a deep understanding of how technology is utilized throughout the sector. This implies recognition of a broader set of research clients than farmers – including consumers, traders, and small and large-scale industrial users – and more effective participation by these clients in setting research priorities and monitoring research products.

10.2. Solving the Coordination Problem: Lessons from Zambia's Maize Breeder-Farmer-Seed Industry-Extension Synergy

Although maize market coordination deteriorated during the 1980s, coordination between maize research, the seed industry and extension was in contrast quite good and contributed to the rapid development of varieties, availability of seed and extension of technology to smallholder farmers in the mid-1980s. What are the lessons? Hybrid maize dissemination in Zambia was helped by the strong four-way relationship between Ristanovic's maize breeding team, small and large farmers, the extension service, Adaptive Research Planning Team, and Zamseed. Ristanovic later described himself as an "entrepreneur" in his dealings with Zamseed, selling and shaping a product for the market. Similarly, another breeder, Dr. Gibson, was an "entrepreneur" among farmers, promoting and soliciting reactions about hybrid and open-pollinated technology. As a result, the characteristics of the new maize varieties met key problems for smallholders: season length and disease resistance. A strong sense that professional success (in the cases of Ristanovic and Gibson) and financial success (in the case of Zamseed and the farmers) depended on cooperation bound these actors together.

The fact that the Swedish International Development Authority (SIDA) funded both maize breeding and the establishment of the seed industry under one project also created interdependence and motivated coordination between the maize breeders and Zamseed. One result was the close relationship between the different hybrids, i.e., a core of parent varieties was combined and recombined in different arrangements, as single, double, and three-way crosses, simplifying and making seed production more economical. Another was the rapid availability of the new hybrids through Zamseed following their release from the breeding program. A key challenge for NARS, and agricultural sectors in general, is to replicate and expand these linkages in maize and other commodity subsectors.

10.3. The Role of Economic Analysis in Research Planning

Zambia is now going through a period of radical economic and agricultural adjustment. Improving the efficiency of maize production in areas where it is economically viable, and developing improved technology for alternative crops are priorities. In this new environment targeting scarce technology development resources to alleviate the most important constraints in the commodity subsector requires an understanding of the dynamic relationship between technology adoption and commodity demand throughout the subsector, and of the institutional/organizational factors that influence demand. This implies a need for the research planning process to be better informed by economic analysis. For example, a reexamination of the economics of improved maize hybrid and variety use by smallholders in different regions under different levels of fertilization, with alternative technologies (such as no-till); analyses of input cost and availability; and analyses of constraints and opportunities for strengthening seed and fertilizer systems, are urgently needed.

A portfolio of economic tools can be used in research planning. They include subsector, domestic resource cost, and rate of return analyses, but these cannot be used in "cookbook" fashion. Meaningful application of these tools requires a careful, situation-specific review of the environment, policies and organizations that influence production and utilization of a given commodity.

10.4. Economic Analysis of Alternative Sectoral Policy and Program Options

Examination of the motivations and implementation of post-independence Zambian maize policies revealed that remote farmers and urban consumers, both groups supporters of UNIP, were the targeted beneficiaries. The lesson from the Zambia case is not that it was bad for the economy to target these groups: that is a political decision. However, a better process was needed to match policy to program and implementing organization once target groups were identified. In the Zambia case, better economic analysis was needed to inform policy makers about cheaper, more sustainable alternatives to using the existing maize marketing system to increase the welfare of remote farmers and urban consumers. Perhaps it would have been extension of rail or road

infrastructure to remote areas, promotion of private sector marketing or high value cash crops, or, for urban consumers, permitting the proliferation of low-cost hammer mills.

10.5. The Important New Role of Government

Zambians have focused in recent years on getting the government away from subsidizing and providing direct services in the agricultural sector, but it still has a vital role to play in investing in "public good" areas such as infrastructure, agricultural research and extension, education and health, where private investment is likely to remain minimal. To encourage more equitable development, rather than a return to a dualistic agricultural sector, the state can also encourage sustainable investment in the more remote areas. This support may take the form of investment in infrastructure, for example. In parts of remote Eastern, Luapula and Northwestern Provinces, the average cost of transporting goods to the nearest district market is six times more than cost for households living close to the line of rail.

In the long term, creation of credible legal systems and a functioning capital market will also be critical to improving the performance of Zambia's agricultural sector. Contract enforcement has already been identified as a major constraint to increased private sector activity in the agricultural sector. Establishing a polity that acts as a third party, policing and enforcing agreements through coercion, has significant scale economies, creating an environment where contracts become self-enforcing, and reducing transactions costs for all economic actors.

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