IMPACT OF MAIZE RESEARCH IN AFRICA

ZAIRE CASE STUDY: SHABA PROVINCE

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INTRODUCTION

Maize is the most important secondary crop in large parts of Zaire, after cassava, the main staple. Zaire is the second largest country in Africa, with a population of 36.6 million in 1990, 70 percent of which is employed in agriculture. Its 1990 GDP was US$ 5.6 billion, 30 percent generated by agriculture, 20 percent by mining. Maize is widely consumed in cities, and on the southern plateaux of the Shaba and Kasai provinces, where it is the staple grain of the majority of the population. It is increasingly grown in Bas Zaire and Bandundu Provinces, to meet the demands of the rapidly growing urban populations of Kinshasa and Mbuji Mayi. Cassava is by far the dominant staple, even in large parts of the maize-growing regions (17 million MT of cassava were produced nationally in 1989, and 800,000 MT of maize.) Both cassava and maize production have taken off since new technologies developed by agricultural research programs reached small farmers. This case study uses the nul hypothesis to illustrate the impact of agricultural research funding. It describes what actually happened, and compares it to the hypothetical situation that might have existed if there had been no funding for agricultural research.

Two major research efforts have introduced high-yielding varieties and stimulated maize production: (1) in 1971-1981 CIMMYT provided a technical team funded initially by the Government of Zaire, and increasingly by USAID. It introduced 6 new varieties, (2) Since 1985 AID has funded agricultural research under RAV I (1983-90, US$ 15 million external funding and $ 11.1 counterpart and GOZ funds, IITA technical team) and RAV II (1990-98, US$ 20.5 million external funding, SECID technical team).

The World Bank, PNUD, FAO, the EEC, Belgium and Canada have been funding other aspects of agricultural research, seed production, fertilizer distribution and extension. Major agricultural extension and marketing projects in the Shaba region since 1979 include USAID's Project North Shaba (PNS) and Project Central Shaba (PCS), and the World Bank's Western Kasai Maize Project (PMKO) and the Mining Hinterland Project (PHM). GECAMINES, the copper mining conglomerate, maintains three mechanized plantations to produce maize for its workers, and Belgian cooperation finances a mechanized farm, Kaniama-Kasese that (before the OPEC oil boom) was supposed to solve Zaire's food problems all by itself. It struggles along, heavily subsidized.

THE POLICY CONTEXT

The national policy context favored urban consumers at the expense of rural producers for nearly two and a half decades.

The particular policies that discouraged small farm food-crop production include:

- From independence until 1990, unfavorable monetary policies: an overvalued currency, scarce foreign exchange used mainly for government projects (neglect of agriculture and surface transport), escalating public debt. Currency devaluation began in 1982-83, followed by floating. Continued government overspending led to hyperinflation in 1990-91;

- Internal taxes on agriculture, and high export duties;

- From independence until 1982, low fixed producer prices for agricultural commodities. Prices were liberalized in May 1982;

- Official monopolies of input and output marketing;

- A free hand for arbitrariness and venality among local and national officials;

- Unstable land tenure and farm organizational policies. In 1974-75 Zairianization, radicalization, seizure of expatriate plantations, meted out to Zairian political elite. This led to a focus on large mechanized farming, pushing small farmers into the background. Peasants were organized into production brigades. Private land ownership was again allowed and encouraged from 1985 on.

MAIZE IN ZAIRIAN FARMING SYSTEMS: CENTRAL SHABA

The prime maize growing region of Zaire is on the mid-altitude and high altitude plateaux of northern and central Shaba Province (Southeastern Zaire) was chosen as a focus for this case study.[1] At altitudes of 900 to 1200 meters, the area receives 1300-1400 mm of rainfall over eight months from October through May. The main consuming area is in the mining and industrial cities of southern Shaba province, but there the sandy savannah soils are less productive.

Two hard days north, by a difficult, sometimes impassible dirt tracks, lie the rolling forested hills where maize grows well. Since colonial times the peasants along the railroad inland from Kalemie have been producing corn-meal maize for

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[1]The author, Lucie Phillips, Koko NZEZA and Dougou KEITA conducted a rapid rural appraisal concentrating on the Kabongo research station and the village of Kamwenzi in February 1991. The results presented here come from that field work unless otherwise identified.

consumers in the mining strip to the south. Some of the villagers who produce it have integrated maize flour into their cassava-based diet, but for many it is exclusively a cash crop. A more tender maize is grown as a vegetable, consumed fresh on the ear.

By railroad, it takes five days for passengers to travel from the market pole to the producing area. Months can go by before freight cars are found to evacuate the crop.

In Central Shaba maize has to find its place among a dozen crops, usually in a common field. In the village of Kamwenzi farmers reported growing cassava, maize, peanuts, beans, rice, squash, bananas, sugar cane, pineapples, tomatoes, sweet potatoes and onions. They also protected oil palms that took root spontaneously on cleared forest land, that matured as it returned to fallow. The trees remain the property of the clearer, who derives significant cash income from their harvest. The most important cash crops, in rank order, are maize, peanuts, bananas, beans and rice. Only recently since the North and Central Shaba Projects brought the technology and developed the markets, has maize been monocropped. Then it is nearly always at the top of a four year rotation on freshly cleared forest land. Most families have both forest and savannah fields, although those without the manpower to clear the forest have to make do with the poorer savannah soils.

The project recommends seeding three to a hole, with 50 cm. between holes in rows 75 cm. apart, then thinning to two plants per pocket. This is exactly the spacing several farmers independently showed us for their first year forest plots. Before the project they used to plant in bunds a meter apart and put four or five seeds to a pocket. Now they use two or three seeds, flat planting and tighter spacing. This contributes to the higher yields they get with new varieties (1.8-3 MT/ha.), forty percent better than they get with traditional varieties and the old Hickory King. Yields for the local sweet-corn varieties are not available. Sweet-corn is grown in small women's vegetable plots behind the village.

The forest lands, villagers say, need no fertilizer and no weeding in the first year, as the rich soil has no weed seeds. Planting is in October, before, or immediately after the first rains. The crop matures in February, but is left in the field for harvesting in May through August. It stores better in the field, loses enough moisture to make good flour, and in any case cannot be transported to market until the rains stop and the roads dry out. By then the fields are a dense tangle of undergrowth full of snakes and other hazards. Harvesting is very difficult. In Central Shaba women have a major role in harvesting, and transport of the harvest by head load to the village. In Northern Shaba some farmers employ pygmy laborers.

Some even burn their fields, which clears the undergrowth, but also chars the maize.

It is actually illegal to try to market maize before the season opens, to protect the roads and allow government officials to monitor trade. A second crop would be possible theoretically with the long rainy seaason, but both farmers and researchers have concluded that pest problems (borer, streak, and downy mildew) are enough worse in the second season to make it non-viable.

On second year forest plots and savannah fields the system changes. Corn rows are more widely spaced, with beans or rice or cassava in between. The intercropping is explained as a means to control weeds and diversify production. It means reduced maize yields, but this does not concern farmers. On savannah fields the soil has to be heaped in bunds, which amasses nutrients but causes wider spacing. Two weedings are necessary on both savannah and second-year forest fields.

In the third year, forest plots cannot be planted to maize, as the weeds win out. These fields are intercropped with cassava and beans or rice and vegetables. The cassava is left in the field 18 months or more, to be harvested as needed for home consumption or cash.

RESEARCH PROGRAMS AND STRATEGIES

CIMMYT and IITA teams followed similar breeding strategies. Both teams decided that only open pollinated varieties were suitable for the unreliable market conditions of Zaire. The goal should be to maximize yields with minimum inputs. The first team tried low-dosage fertilizer packages, and the second did without it entirely. In the 1980s improving nutrition and the return to labor were also goals, according to the project paper, but little monitoring of these factors was done. Breeding for resistance to streak virus, downy mildew and striga have been attempted since the 70s, but with little practical success.

The improved open-pollinated varieties produced by the CIMMYT/GOZ team in the 1970s are widely disseminated throughout Zaire today. Most of the credit for increasing corn production should go to them. Data on adoption is spotty, but it is clear that farmers in all of the prime growing regions of eastern, central and southern Zaire are using them. The PNM station at Gandajika has helped the Kaniameshi station provide foundation seed and some commercial seed to other provinces (the Kasais, Bandundu and Bas Zaire). PNM maintains outreach stations at Kikwit (Bandundu) and Mvuati (Bas Zaire).

Zairian varieties have also found favor beyond national boundaries. The middle and lower altitude variety Kasai I is

exported in small quantities to neighboring countries, including Congo and Cameroon, where it is prized by commercial growers.

PNS and PCS recommended that farmers renew 1/3 of their seed each year. Up to 96 percent of farmers used improved seed in the tenth year of extension by the North Shaba Project, but it is not clear how often they were renewing it.[2] Only 41 percent were using it when the project began.

The USAID funded RAV/PNM project produced five new varieties in the latter 1980s, but these have not been released. Projects such as North and Central Shaba, Bandundu and Bas Zaire tested these varieties, and their farmers asked for permission to use them. The most promising of the latter's varieties, Babungo 3, with no fertilizer, produces 32% better yields on station than Shaba I, the first generation mid and high-altitude favorite.[3] It has better streak virus resistance, which is the main cause of crop loss in Shaba. With fertilizer the average yield gap between Babungo 3 and Shaba I increases to 47 percent. PNM managers, however, seem not to have been able to complete enough multi-locale and agronomic tests to release them with confidence. They appear to be more afraid of being blamed if an epidemic sweeps through than they are anxious to have credit for improved production. Now that the expatriate team has left and the Zairian director of PNM died, prospects for release of these varieties are dim. This is a case where weaknesses in management, criticized in the USAID evaluation, resulted in clear loss of opportunity.[4]

Improved agronomic practices alone could increase yields 45 percent, on-station tests with local seed showed.[5] Timely planting, within a few weeks of the first rains, proved the most important factor. Delayed plantings fell prey to borers and streak virus when the plants were in vulnerable stages. Optimum levels and timing of fertilizer, rotation following legumes, plant densities, weeding timing, and bunding vs. flat planting were the main themes. Except for early planting, which farmers already practiced, few of these techniques have been adopted by

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[2]BUKAKA Bonani, 1989 Farming Systems research and extension strategy: The diffusion of high-yielding variety maize technology and socioeconomic change in rural Tanganyika Subregion--Zaire, Univ. of Wis., Madison, Ph.D. thesis.

[3]Edgar J. Ariza-Nino, Nathan Associates, "Impact of Agricultural Research in Zaire," USAID consultant report, May 1989.

[4]Chemonics for USAID/Zaire, RAV I, End of Project Evaluation.

[5]USAID/Kinshasa, Action Plan 1990-1993.

farmers. The main factor is that farmers are more interested in saving labor than in increased yields per se. Fertilizer use is also hampered by lack of capital, transportation, and marketing.

Land is not the main constraint for rural Zairian farmers; labor is.[6] High-yielding seed varieties often produce a better return to labor, which accounts for most of their success with farmers. Better agronomic practices, on the other hand, sometimes involve more labor, or labor input timing that does not fit with other obligations. Another factor is that intercropping is common on Zairian peasant farms, and the agronomic practices recommended were until recently designed for monocropping.

The farming systems research component was weak in both the CIMMYT research and RAV I (IITA/USAID). Extension projects generally worked out their own agronomic recommendations, relating them to local farmer practices and cropping patterns. Greater emphasis on farming systems and on returns to labor have been written into the RAV II project, but there has not been time to see results.

The debate between hybrid and open-pollinated strategies has been costly in Zaire. CIMMYT advocated open-pollinated varieties and minimum inputs from the beginning (1971). The big GECAMINES and private farms in Shaba were already using hybrids, importing the seed from Zimbabwe, Zambia and South Africa. Some progressive peasant farmers were obtaining it also. So there was a market for hybrid seed. But hybrid seed required fertilizer. Only 5000 T was in use in all of Zaire in 1970, most of it going to commercial crops. CIMMYT wanted to reach poor farmers, those who had little cash, no credit, and difficult access to transportation for inputs and crop marketing. With open pollinated varieties these farmers could produce, even if little fertilizer was available or seeds arrived late. Nevertheless, the benefit of even small amounts of fertilizer, especially on the poorer savannah soils, was so significant, that PNM provided input credit and recommended 64 kg/ha of nitrogen for poor farmers. Higher doses were recommended for wealthier farmers.

PNM and CIMMYT were pressed from both directions concerning the level of inputs. The North Shaba project, under Development Alternatives Incorporated direction, wanted to reach the poorest of the poor. It recommended no inputs except open pollinated seed, which strained relations with PNM to the breaking point.

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[6]Except around urban areas, good agricultural land is generally available in Zaire for whoever clears it. The relative underpopulation is evident from macro-economic statistics. The greater importance of the labor constraint was confirmed by extension personnel and farmers themselves during our rapid rural appraisal in the Kabongo area of Central Shaba.

It got its seed initially through Kaniama-Kasese (which used foundation seed from PNM).

On the other side of the debate, some local policy makers wanted the maize program to produce hybrid seed, in order to build local institutional capacity in that technique and to save foreign exchange used for imported seed. CIMMYT began working on hybrids in 1980, its last year in country. The IITA team that arrived in 1985, however, was even more opposed to a high-input strategy than CIMMYT. The hybrid program was stillborn.

Then in 1987 PNM's research station at Kisanga, newly renovated by AID, was repossessed by the Presidency and put into the hands of a Yugoslav-trained Zairian researcher and some Yugoslav technical assistants. They persuaded the authorities that hybrids were more productive and modern than PNM's composites, and promised to produce them. They founded the National Maize Center (CNM), which diffuses reputedly poor quality hybrids derived from Zimbabwean SR-52. The seed competes with PNM's seed. Neither research service likes the competition, but it may in the end be good for farmers. At least, if the seed were packaged and labeled, farmers could test and choose themselves. At present farmers do not always know what seed they are buying. BUNASEM, which has a mandate to control seed quality, is not yet effective in that area, and seed is generally distributed without certification. Farmers rely on their confidence in the provider, which poses severe problems for the new effort to put seed distribution in the hands of local traders. What measure greed and ambition played in the loss of Kisanga is debated, but there was also a kernel of scientific debate.

PNM moved its headquarters to Kaniameshi, and AID again renovated and equipped the offices. Then in 1990 the Presidential guard occupied them, claiming a security need. AID broke off its assistance in January 1991, and redeployed the newly arrived SECID RAV II research team. The PNM administration may have recently found a compromise, but it has taken most of a year. Despite these disruptions, PNM has produced foundation seed each year and preserved its germ plasm collection, vital functions which are the threads of continuity that keep the research program productive.

A program emphasizing hybrid production could not have survived the administrative disruptions that PNM has experienced. Seed and other inputs have not gotten in adequate quantities to distributors, and from them to each farm each year on time. They would have had to do so for a hybrid program to work. Nevertheless, the thriving hybrid-based maize production of Zambia just across the border niggles on Zairian agricultural strategists' thinking. What they do not realize is that it is heavily subsidized, and close to collapse from economic strains.

AID and the World Bank now are pressing Zaire to privatize the seed production and distribution network. This has revived the hybrid debate. An AID consultant has argued that private seed production and distribution can function only if it is hybrid based.[7] With composites, he argues, the market is too small and uncertain, and distribution too difficult to control. AID is staying with composites at present. Its efforts to involve local traders are progressing slowly, encountering resistance from farmers and traders, and sometimes from project personnel, frustrated to see their farmers lack seed.

Over the long term, making seed distribution profitable is the only way to assure that farmers continue to get it. In current market conditions in Zaire, hybrid or composite is not the main question. More basic needs for private businesses are a decent transportation network, and the creation of a legal and regulatory framework that reduces risk and establishes confidence. Certifying and labelling seed, and providing written instructions with it, for example, can build both farmer and trader confidence. Farmers now haggle with traders, buy at fluctuating prices on variable credit terms, and fight over what has to be repaid at harvest time. Neither participant likes the process.

THE RESEARCH INSTITUTIONS

INERA, the national agricultural research institute which succeeded INEAC, maintains 20 field stations, 6 of which are considered primary. It is primarily funded by Belgium and still maintains a high level of Belgian technical assistance. In the 1970s a commodity focus was decided upon, and a CIMMYT team brought in to staff and train the maize component, PNM. At first the funding was largely by the government of Zaire, deeply concerned by the drain maize imports placed on its foreign exchange. USAID gradually assumed a greater role in its funding.

When AID decided to take over full funding responsibilities in the early 1980s, it insisted on institutional restructuring. The three commodity programs for which AID assumed responsibility were removed from INERA and its titular Ministry of Higher Education and Research. A new structure, SENERAV or RAV, comprised of the three commodity programs (Maize, PNM; Cassava, PRONAM; and Legumes, PNL) and a central management unit, was created directly under the Ministry of Agriculture. AID wanted it to have a less academic, more applied approach, and to collaborate more easily with the Integrated Rural Development project it was creating, Project North Shaba. This institutional

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[7]Lowell S. Gleason, Maize Hybrid Seed Industry Appraisal for Zaire, May 1990.

strategy was costly, but seems to have made its point. The traditional "pure" research had produced interesting results, but with no systematic effort to disseminate them to small farmers. CIMMYT and AID brought an entirely different philosophy, which quickly reached farmers, even in extremely remote North Shaba province. Now this philosophy has penetrated INERA as well, and the time has come to reintegrate the separate institutions. In 1992 RAV is scheduled to return to the INERA fold.

TRAINING AND INSTITUTION BUILDING

Building an indigenous capacity to conduct and manage research has been a focus of both RAV research programs. The CIMMYT/GOZ program trained 9 Masters and PhDs, and 22 short term trainees. All but three of them had left the research service by 1985,[8] but one of the PhDs headed the maize research program (PNM) from the early 1980s until his death in 1991. PNM/IITA from 1985 to 1990 put 38 candidates into MS and Ph.D. training, of which 9 finished and 29 continue. Training agreements now require trainees to serve their institutions for a time span equal to their training. After that service, departures for more interesting jobs are still common, and are still considered a major loss, from the point of view of the NARS. Not all of the training of those leaving should be considered lost, however, as many of the trainees go into PVOs and international organizations. Often their training is put to effective use in their new jobs, and they have more resources with which to work. Salaries in INERA range about $110 per month for experienced masters-level personnel with administrative responsibilities.[9]

///Review no. of tests, etc. relative to funding/staffing mix. Elon, I need to show you the data and see what you make of it. My feeling is that, like the longevity data, it will only make sense when analyzed for several countries.//

SEED MULTIPLICATION, INPUT PROVISION AND EXTENSION

PNM works mainly through 139 PVOs and projects.[10] PVOs and projects have had to "do it all" in Zaire, but they have

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[8]N.N. Mulamba and M.Y. Asanzi, "Maize Research and Production in Zaire," in CIMMYT 1985, note, "Because of economic difficulties (salary and facilities), most of that staff have left the program. Today the program has only one PhD, two with Master's degrees and seven agronomists with bachelors degrees."

[9]Rep. of Zaire, National Institute for Agricultural Study and Research, Auditing of Financial Statements as of December 31, 1989; Annexes on Personnel Census, February 1991.

[10]Chemonics, 1990 RAV I: End of Project Evaluation.

gotten results. Extension, applied research, credit, marketing of inputs and outputs, road repair and railroad improvements are the ingredients in many projects. Most projects focus on the food crops for which agricultural research has provided improved varieties: cassava, maize, rice and peanuts. PNS introduced on-farm research, which resulted in substantially modified recommendations to suit local farming systems. It had poor relations with PNM, in fact, from then on, essentially because it refused to recommend any fertilizer use, while PNM recommended low doses. Late planting proved to cause much greater pest losses than could be offset by fertilizer use, and farmers in that isolated area who became accustomed to purchased inputs ran a high risk of planting late. The trade-off, that has only become evident with time, was that farmers cleared more and more virgin forest land to get the fertile soils maize needs. After two maize crops and two years of cassava/bean/other vegetable intercropping, a forest field returns to fallow. A PNS adoption survey in 1986/87 showed 97 percent of farmers in the area were using improved seeds, and 78 to 89 percent were following the agronomic recommendations.[11] This project was perhaps a victim of its own success. It was well equipped, and when it was being redesigned to expand into Central Shaba, the Northern Shaba project management decided they would rather have the equipment and end the project.

The 5000 strong national extension service is underpaid, poorly trained and immobilized by lack of equipment. The World Bank Training and Visits (T&V) approach is being introduced in a pilot project that started in 1989 at 3 sites.[12] The national fertilizer program (PNE) reached mainly commercial farmers when it had foreign exchange. The food production increases in Zaire owe little or nothing to fertilizer. They accelerated in the 80s, when fertilizer use was declining even for cash crops.[13] National seed production and distribution efforts have been plagued with inefficiencies, but have been an essential link in the chain. PNM initially provided foundation seed to Kaniama Kasese, the big mechanized Belgian-aided farm project. In the 1980s seed production is supposed to have been shifted to a commercial basis with a national seed service, BUNASEM, and distribution by PRAAL (The Action Plan for Food Self Sufficiency). The former has produced more seed than the market

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[11]Bukaka, Bonani, 1989, p. 188.

[12]World Bank, 1990 "Rapport d'évaluation, Zaire, projet pilote de vulgarisation."

[13]Total fertilizer use increased from 1000 MT in 1965 to 11,000 MT in 1975, and then declined to 7,000 MT in 1985. (FAO, 1990, Basic Data on the Agricultural Sector, Country Tables)

can absorb, but of poor quality.[14] The latter succeeded in selling at subsidized prices only 40 percent of what it bought,[15] and is being abandoned in favor of sales directly from the nine private seed farms affiliated with BUNASEM.[16]

IMPACTS AT THE NATIONAL LEVEL

Despite an unfavorable policy context, deteriorated transport and notorious weakness of the extension service, the new varieties produced in the 70s have been steadily reaching larger and larger numbers of farmers. Maize production increased more slowly than the population at first. It went from 326 thousand metric tons in 1960 to 428 thousand in 1970, and 562 by 1980[17]. (see Figure Zr1, Zaire Corn) The average annual growth rate was 2.8 percent, compared to a population growing at 3.1 percent per year. By 1988 maize production had reached 800,000 metric tons, a growth rate for the 80s averaging 4.6 percent per year. Nationwide, the percentage of caloric consumption provided by maize increased from 7.6 percent in 1961 to 9.5 percent in 1985.[18] It was from 1975 on that new high-yielding, low input maize varieties reached large numbers of peasant farmers. This is what made the difference.

Since small farmers were using no inputs, yields actually declined according to national statistics. This is because the small farmer yields in the 80s are being compared to those obtained by subsidized mechanized farms with fertilizer in the sixties and early seventies. Yields obtained by small farmers with no inputs were nevertheless estimated 40 percent better than

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[14]Edgar Ariza-Nino and William Guyton, 1990 "Maize Seed and Grain Marketing in Central and North Shaba," USAID/NATHAN/CHECCHI.

[15]Lowell S. Gleason, 1990.

[16]IDA/DAGZ, PNUD, FAO, Zaire: Plan National Semencier: Rapport de la Mission d'évaluation mi-parcours (24 janvier- 16 fevrier 1989), 3 Mai 1989.

[17]FAO, 1990 Basic Data on the Agricultural Sector, 1990: Country Tables, for data 1960 and 1970. USAID/Zaire, 1990 Action Plan, FY 1990-1993 for data 1979-1988.

[18]FAO, 1990.

with their traditional varieties under the same conditions.[19] On farm trials conducted by PNS showed:[20]

	Savanna MT/ha.	Forest MT/ha.
Traditional Practices/Local var.	0.8	1.8
Traditional Practices/Kasai I	1.2	2.4
Improved practices/Kasai I	1.7	3.2
Improved Practices/Kasai I/Fert.	2.7	5.2

The yield improvement, together with extension and marketing programs, was enough to encourage them to plant maize on a large scale as a cash crop. The area planted to maize and total maize production have been growing steadily, while other areas of the economy experienced grave difficulties.

Zaire had to import 100,000-200,000 MT of maize in 1969 from Southern Africa,and feared that by 1980 the need would be 500,000 MT.[21] This was one of the main motivations for calling in the CIMMYT agricultural research team. With the production increases of the 70s and 80s, imports have declined substantially since their peak in 1976. Official imports in 1990 were 64,600 MT and declining.[22]

The growth in local production has probably contributed to keeping maize prices lower than they would have been, but the markets are so imperfect that this cannot be demonstrated statistically. Prices vary from simple to double or triple locally within a region, seasonally and from year to year. In 1990 prices climbed to three times their opening level by the end of the season. USAID maintains producer price statistics, which show maize prices in the $1.30 to $1.50/kg range from 1982-87, peaking in 1983 (during a drought year).

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[19]This estimate is an average taken from projecting the yield differentials in on-farm trials under differing conditions, and estimating the number of farmers practicing those conditions. The purity of both "local varieties" and "improved varieties" is questionable, as farmers have for years mixed their seed, and research stations have not always been able to control pollinization themselves.

[20]Ariza-Nino, May 1989.

[21]The 100,000 MT imported by official channels in 1970 was estimated to be only half of what actually arrived, as clandestin importation of maize and flour across the Zambian border was well organized.

[22]USAID, Food Needs Assessment, 1991.

An example of the distortions in markets can be taken from Shaba province in 1990. At the beginning of the trade season in May 1990 farmers in Central Shaba received Z 5000 ($9.13) in the village for a bag of grain nominally weighing 100 kg (real weights are 85-105 kg.). By December they were getting Z 15000 ($9.12), and occasionally as much as Z 25000.

There is a sixty percent price differential between a village 30 km. away and its railhead. Transport in the villages is limited to head loads, and very few farmers have the means to move their maize to the railroad stations. Prices multiply several times again from railhead to mill. By the time a bag reaches the main rail line at Kamina, it cost Z 22,000 last year, while villagers only got Z 5000. Grain often sits for months waiting for cars to be available, months during which it is consumed by insects and rotted by mold.

PROJECT AND PROVINCIAL LEVEL IMPACTS

Northern Shaba was already a commercial maize producing area when PNS was established there, and began introducing new varieties. It produced 5000-8000 MT per year, using mainly a seed of American origin introduced by the millers, Hickory King. At the peak of project life in 1987-88 it was producing 45,000 to 50,000 MT.[23] Production is believed to have dropped somewhat since the project was ended, as markets are no longer monitored and seed is not being renewed.

The Central Shaba project area has less fertile soils and slightly lower yields than northern Shaba, but PCS is having an impact here similar to that of PNS in north. In the second year of project field work, production is already estimated at 10,000-15,000 MT. Before the project began, the area produced sweet corn only for home consumption, so this is all net gain. Its value to farmers would be $100,000 to $150,000, in a zone which had only minimal cash circulation before the project began.

The whole of what is called the Eastern Region used to ship 100,000 MT south on the railroad. The Eastern Region is basically the the area served by the Kamina-Kalemie spur of the railroad, including central and northern Shaba province and part of southern Kivu. Service on that rail spur has become so sporadic that its traffic no longer provides a reliable index of maize production. Most of the production is being trucked to the Kasai area markets now. This year the Eastern Region spur shipped only 30,000 MT of maize to Lubumbashi markets. Some of the difference may be due to declining production since the PNS

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[23]Bruce Spake, Administrator of the Shaba Regional Development Office (SHADO) of USAID provided the statistics.

project ended and seed is not being renewed, and some may be due to changing trade patterns.

The contribution to maize production attributable to improved varieties in the World Bank PMKO and USAID North and Central Shaba project areas was evaluated in 1989, based on the seed actually distributed that year and the residual effect of seeds distributed in the previous two years.[24] PNS and PMKO had ceased to function the previous year. The calculation showed a production differential of 8.3 kilotons, equivalent to a gain in local farmers' revenues of $830,000. The benefit to consumers, millers and traders was still greater, as the cost of importing that amount of maize that year to Lubumbashi would have been $2.2 million. The cost of the PNM research program that produced the technologies was just over $1 million per year, including foreign currency costs and the GOZ costs attributable to Shaba Province staff.

FARM LEVEL IMPACTS OF MAIZE RESEARCH

Farmers get about $90-100 a ton for their maize, and produce one to five tons per family. The average is about 2 tons.[25] This amounts to $200 per year in cash income. This is a great boon in an area where total production, including that consumed on the farm, is estimated to average $100 per capita per year. People use the income to get metal roofing, improve their houses, and buy meat and fish, tools, radios, bicycles, chickens, and other consumer goods.

Although only small amounts of maize are consumed by the growers, it has clearly improved their diets by allowing them to buy protein-rich foods. A nutritional component of PCS is teaching farmers to make soy milk, combining soja and maize in a protein-rich food. This is an excellent weaning food, capable of reversing the critical pattern of young child malnutrition. Adoption rates for this project component, however, seem to be low. Farmers are planting less soja than the first year, because they cannot market it and do not traditionally eat it.

LESSONS LEARNED

Surprisingly Zaire is a success story for maize. The constraints encountered have discouraged many participants, both Zairians and donors. Yet the catastrophic food shortages that

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[24]Ariza-Nino, May 1989.

[25]The villagers interviewed in Kamwenze, classed as medium or poor by their neighbors (and themselves) claimed to plant about a hectare of maize and to harvest twenty bags (ca. 2T). The wealthier farmers had up to 2 ha., with up to 50 bags (5T).

the GOZ feared when it called in CIMMYT in 1970 have not materialized. The increase in small farmer production, made possible by the open pollinated varieties that that team produced, led imports to decline, prices to stabilize and the proportion of maize in the diet to increase.

The most important factors of its success come from three key actors: IARCs, NARS and PVOs/IRD projects. Without improved germ plasm, applied research on agronomic practices, and regular supplies of foundation seed, PVOs and IRD projects could have done little. Without the IRD approach, the research results would have reached the farmers in such adulterated form as to have had little impact. One of the determining forces has been NGOs and projects willing to deal with market, transport and bureaucratic obstacles as well as extending research results effectively to farmers.

The last decade's efforts to relieve policy and procedural constraints at the national level have succeeded in changing declared policy at the top, but have as yet had little impact in isolated rural areas. The private sector still lacks the transportation, communications, legal and judicial framework necessary for it to function. Efforts to put input distribution and marketing on a commercial basis are promising, but not yet a working reality. Seed distribution is not, in itself, a profitable enough line to motivate traders to deliver to isolated areas in a timely fashion.

The critical dilemma in this farming system is that maize production causes the forest to be cleared. After four years of cultivation it returns to fallow, becoming secondary forest after a number of years. Secondary forest does not support the same rich flora and fauna as primary forest, nor is the fertility of the soil fully regained. Opinions differ over how serious the pressure on the forest is. To most local observers forest land appears abundant, even in the prime growing areas. The project areas are not encroaching on Zaire's designated forest reserves, which occupy 4 percent of its total land area. In the old prime growing area of North Shaba, however, the best forest lands are exhausted. Along the railroad and near rivers there is obvious deterioration. Farmers there have to go many kilometers to find new suitable lands, and traders complain that they must range up to 100 km. from the rail now, whereas a decade ago they could collect the entire crop with 25 km. of the railheads. Foresters point out that much of the cleared forest land gradually becomes savannah, and that the clearing along waterways destroys prime wildlife habitats.[26]

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[26] Zaire: Plan d'Action Forestier, FAO/USAID/Canada, 1990

Extension project personnel and PNM researchers are seeking a sustainable system using green fertilizers. Crotalaria, leucena and soja all improve maize yields on savannah lands when intercropped for several years, or grown at the top of a rotation. Unfortunately, savannah fields thus enriched still do not match yields on forest lands. The green fertilizers do not show appreciable yield gains on already fertile forest lands, which makes researchers doubt whether they could motivate farmers to use them there. (They apparently have not tried it to find out.) Farmers say they would be interested in sustainable agriculture and green fertilizers, as clearing the forest is their heaviest work.

The policy of using no chemical fertilizer, which has become unexamined dogma, should also be reassessed. Some fertilizer is reaching the area for other cash crops, and fertilizer has been successfully distributed to equally isolated areas of Africa for cotton cultivation, for example. The fixed technical packages some extension services believe they must impose on farmers need to make room for more flexible approaches, letting farmers choose what best suits their circumstances. The harder working farmers with better labor supply (usually just their own larger families), would probably use both green and chemical fertilizers. Most farmers already understand that they should not wait for fertilizer deliveries; planting on time is more important. But encouraging fertilizer marketing would give private seed traders a more viable second line of trade, improve yields, and possibly help reduce the rate at which forest lands are cleared.

Had there been no agricultural research in the 70s the most obvious lack would have been the high-yielding open-pollinated varieties the program produced. Extension projects in Shaba Province would surely have used hybrid seed imported from Zimbabwe and Zambia, which is what most of the big mechanized farms use. It is likely that PNS and PCS would never have been funded, or would have tried and failed. In those remote areas of the province it is unrealistic to organize the full-scale seed and fertilizer delivery that would have been necessary with hybrid seed. The losses from late deliveries would have exceeded the yield gains from improved technologies. Small farmer projects would have been confined to the southern part of the province, where soils are poorer. More reliance would have had to be placed on subsidized mechanized farming. IRD projects would have had to expand their adaptive research components, each site doing its own testing of planting dates, densities, fertilizer dosage and timing, and disease control techniques. If one assumes the same level of communication between project sites as one finds today, there would have been almost no written communication of research results, and substantial duplication of efforts.

Since the CIMMYT team and later AID funded teams produced such a radical reorientation of research goals and practices, a variant of the nul hypothesis suggests itself here. Had there been no CIMMYT and no IITA intervention, INERA would likely have continued to do research in the Belgian/Zairian mode. It would have continued to produce scholarly articles shared largely among the research community, and distribute results mainly to the mechanized farms.

In such circumstances neither the extension nor the intensification of maize production that took place could have happened. An optimistic hypothesis would be that maize production might have continued to grow at the same rate as the rural population, ca. 2.5 % per year.[27] With 330,000 MT in 1965, this would have meant 612,000 MT in 1990. If one assumes that the increased consumption of maize over that period is largely related to urbanization, and is relatively inelastic, most of the 188,000 MT annual shortfall would have had to be compensated by imports, say 180,000. The cost of additional imports for 1989, for example, would have been ca. US$ 43 million, delivered to Lubumbashi, the center of southern Zaire's market area.[28] The foregone income to Zairian farmers would have been about US$ 18 million that year. North and Central Shaba farmers alone would have experienced about Z 280 million, or Aug. 1980US$ 693,000, assuming 70,000 MT in foregone production.

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[27]The optimism here comes from discounting the role of mechanized agriculture, which in the 1960s was still producing a significant portion of the maize. By 1990 most of these farms had been abandoned, and those that remained reported declining production.

[28]This assumes the $240/MT CIF Lubumbashi price GECAMINES was paying for southern African white maize in 1989. (Source: Ariza-Nino and Guyton, 1989) Import prices should be calculated partly in CIF Kinshasa and Kasaian towns prices, but the price data is not available. For such a hypothetical calculation, this would be too fine a point in any case.

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