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Good News from Africa

– Farmers, Agricultural Research, and Food in the Pantry

IFPRI

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The International Food Policy Research Institute in collaboration with:

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International Centre for Research in Agroforestry

International Centre of Insect Physiology and Ecology

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International Institute of Tropical Agriculture

International Livestock Research Institute

West Africa Rice Development Association

Ebbe Schiøler

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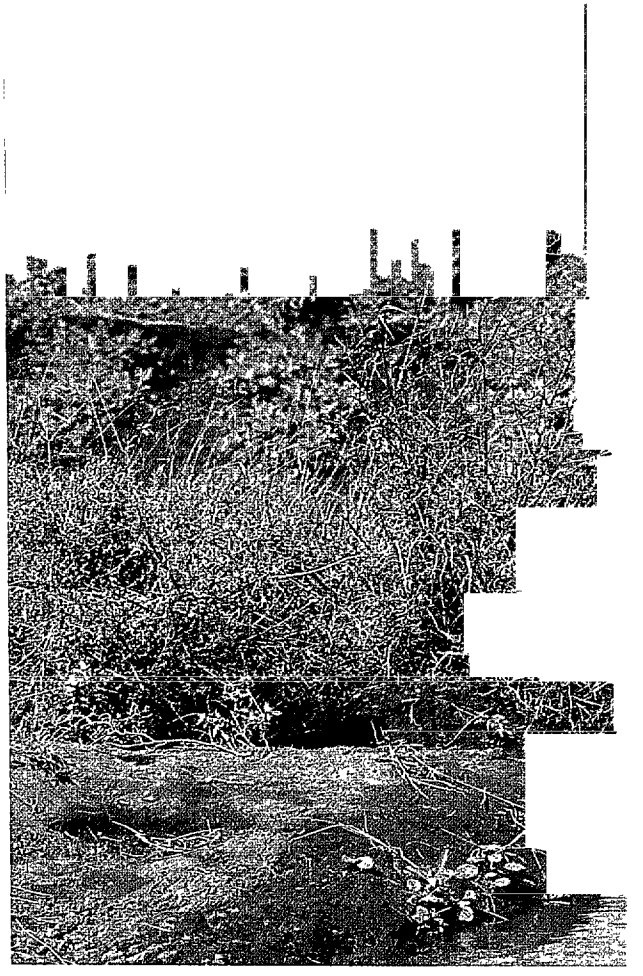
The International Food Policy Research Institute was established in 1975 to identify and analyze alternative national and international strategies and policies for meeting food needs of the developing world on a sustainable basis, with particular emphasis on low-income countries and on the poorer groups in those countries. IFPRI is a member of the Consultative Group on International Agricultural Research, an association of 16 international research centers, and receives support from a number of governments, multilateral organizations, foundations, and other sources. All of the other research centers that contributed to this volume are members of the CGIAR system, with the exception of ICIPE (International Centre of Insect Physiology and Ecology).

Table of Contents

Foreword



Effective use of science to solve poor peoples' problems, including hunger and malnutrition, is one of the most important and potentially rewarding challenges facing humankind. Millions of people have escaped hunger and malnutrition because of the technology and knowledge developed through agricultural research. Yet, the impact of agricultural research on the daily lives of low-income people is not well documented.

In *Good News From Africa,* Ebbe Schiøler provides illustrations of how international agricultural research has affected the everyday fare of African villages. The stories are based on the author's visits to 12 communities in five countries and his meetings with the families described. In my opinion, this book is the best available account of how applied science can improve the lives of ordinary African families.

Good News From Africa was originally written in Danish and published by the Royal Danish Ministry of Foreign Affairs in April 1998. With a few additions and modifications, it has been translated into English by Barbara Haveland for publication by IFPRI. The cost of the production of the Danish version was covered by the Danish Ministry of Foreign Affairs. The cost of translation and production of the English version was shared by nine Consultative Group on International Agricultural Research (CGIAR) centers and one independent center acknowledged herein.

I believe that this book will contribute to a better understanding and appreciation of the impact of agricultural research in general, and CGIAR research in particular, on the well-being of people everywhere.

Per Pinstrup-Andersen
Director General, IFPRI
Washington, DC
September 1998

Preface

Many a dull story could be written about agricultural research. Tales of long days in the laboratory, of thousands of hybrid plants on endless test fields, and of all the experiments that wound up down so many blind alleys. That is how it is with research: for every viable result, a great deal of hard work has had to be put in – sometimes in vain. Not until the work has generated some applicable results does anyone apart from the specialists start to show any interest in it.

This book touches only briefly on the actual research process. Instead, it concentrates on describing some of the countless research breakthroughs that are helping farmers in Africa get more out of their land. Thus the stories presented here serve, above all, as proof of the fact that results can be achieved – even in Africa. Here you will find stories from Ethiopia, Côte d'Ivoire, Kenya, Uganda, and Zimbabwe. But there are hosts of other such stories to be gleaned from these and other countries all across Africa

Behind each breakthrough lies one of the international centers for agricultural research, which work hand in hand with local authorities and national researchers. But it is the small farmers who have shown, in practice, that all of the researchers' hard work is worthwhile. And that practical testing, out there on the farmers' own small plots, is what this book is about, because it is there that the value of the research is put to the ultimate test.

The pantry is pretty bare; it needs to be stocked with food, and this food must be produced in a sustainable manner, without degrading or polluting the natural environment. That, too, is the subject of these stories.

By and large, in the examples quoted here this double endeavor has borne fruit. Hence the title: *Good News From Africa.*

Also included are four theme pages on agriculture and food supply in Africa. The material for these themes has been compiled by IFPRI, the International Food Policy Research Institute. Three of the theme pages I have framed, while the page on nutrition is the work of associate professor Kim Fleischer Michaelsen of the Royal Danish Agricultural University in Copenhagen, Denmark.

Ebbe Schiøler
Chief Advisor, Research
Royal Danish Ministry of Foreign Affairs, Danida

Yes, we do have bananas

Uganda

Early this summer Daniel Rwaheru had his reliable old bicycle stolen. For many of his neighbors in the village of Ntungamo in southern Uganda this would have been a hard blow. A new bike costs about US$35. But Daniel was undaunted, not because he is particularly well-off, but because he belongs to a group of banana farmers who have set up their own credit union. And through this he obtained a loan to buy a sturdy new Indian-made, steel-framed bike.

Two years ago being without a bike would not have been such a problem. Back then there was no need to make so many trips or to haul such heavy loads. It is the banana researchers who are to blame for all the extra lugging that he now has to do. But Daniel bears them no grudge. He is more than happy to be pedaling down the rough, dirt track to the main highway with his load several times a day.

Banana country

Bananas – that is the load. Great bunches, bulging with plump fruit, and green as rhubarb leaves, as they should be. They are difficult to peel and do not even taste good when raw. But that is just fine, because these are not the sort of bananas we are used to seeing at home: yellow, sweet, and aromatic. Yellow bananas are also to be found

A sturdy bike is a must when it comes to lugging 100 kilos of bananas from the plantation to the main highway

Previous Page Blank

Get your bananas here! This market woman will be sold out by late afternoon A lot of bananas are needed for just one dinner in a Ugandan family

in Uganda, but here they are known as dessert bananas, served up in small portions.

The main staple here are the cooking bananas, the green ones. They play the same role as would potatoes, rice, or pasta and are prepared in much the same way. The recipe – for anyone who may be interested – is very simple. Take some large banana leaves and arrange them criss-cross fashion on the floor. Peel 50 to 60 cooking bananas – enough for three or four people – and pile these up in a mound on the banana leaves, which are then drawn together to form a parcel and tied tightly with fibers from a leaf. Place three or four pieces from the stalk of a young banana plant in the bottom of a large pot and barely cover these with water. Set the pot on the fire and leave the parcel of bananas to steam for at least an hour. The parcel is given a good pounding to ensure that the flavor of the leaves is absorbed by the mashed bananas. They are served preferably as part of a larger main meal, but may also constitute a meal in themselves.

In certain parts of Uganda, and certainly over most of the southern region of the country, up to 60 percent of the daily calorie requirement is derived from bananas.

Green mountains

Driving around the area, there is no doubt about the importance, here, of the banana Overladen bicycles abound, with bunches of bananas hanging down on either side of the rear wheel and often one on the carrier as well. All are making their way to the collection points dotted along the highway where, at the end of each day, trucks are filled to overflowing with bunches by the ton.

During the evening and all through the night the convoys drive the 300 kilometers to the capital of Kampala, where the green mountains in the fruit market on the outskirts of the town will dwindle to nothing over the course of the day. At this end, too, bicycles are needed: one family will never buy less than a whole bunch.

Greedy bananas

Bananas are practical enough when you are just picking up a bunch on special at the local supermarket. Neatly packaged by nature's own hand, clean and delicious when peeled. But in the natural cycle they do, in fact, pose something of a problem. Scientists have calculated that around 30 percent of all the biomass produced by a banana palm is lost from the soil.

In other words, there is a nutrient imbalance in the soil, and this has seriously damaged banana production in Uganda. The central part of the country used to be the main banana-producing region. But during the 1970s, as the soil was gradually starved of nourishment, problems with disease and insects became so great that banana production shifted south to more fertile areas. Here the bananas did better.

But only for a while. As the soil here, too, was exhausted, banana production fell.

A vicious circle ...

The poorer the soil became, the less resistance the banana palms had (although they are not actually palms, but perennials). And the less resistant they became, the more disease and insects flourished and the faster the damage spread to other banana plants.

There were two major problems, one almost invisible and the other totally so: the banana beetle, which only comes out at night, above ground, and a fungal growth attacking the roots below ground, 24 hours a day.

The insects lay their eggs in the surface layer of soil, just at the point where the banana stem begins. These develop into larvae that gnaw their way through the stem, leaving, in a good season, a band measuring as much as 15–20 centimeters (6 to 8 inches) riddled with their boreholes. This leads to a reduction in the transmission of nutrients and water from the roots to the top of the plant. The banana palm either becomes stunted or shrivels up completely. In those spots that are hardest hit, the plants topple over, providing the perfect hatching grounds for the next generation of beetles, who will then set to work on other banana palms. And from then on, it's downhill all the way.

The fungus at the roots has a similar effect. It spreads up into the stem and blocks the plant's delicate arterial system. In the worst cases the plant comes crashing down when the roots wither away. Planting new palms does not do any good, since these, too, will soon fall foul of the two pests.

... and a beneficial one

Bananas grow from one main shoot, from which sprout a number of side shoots. One strong main shoot is left to grow, and two side shoots are retained. Within approximately 18 months the main shoot will bear one bunch, which is harvested by lopping off the main shoot. One of the two side shoots grows on to become a main shoot, and a new side shoot is allowed to sprout.

Thus the roots are constantly producing new shoots that will in turn bear fruit all year round. Tend your banana plot well and bananas will always be in season.

The International Institute of Tropical Agriculture (IITA) in Nigeria had been working for some time on solutions to the problems of banana growing. In West Africa they had come up with four winning cards that, when combined, made all the difference between the years before and after 1995 in Daniel's village, Ntungamo.

The simplest of these was for the stems not to be left where they fell during the harvest. If, instead, they were chopped up into little pieces, the pernicious beetle would have no chance of laying its eggs there. The stems were also to be cut off right down at the roots, allowing no hatching ground for the larvae there either. Most farmers can manage this, and it is so easy that children old enough to wield a panga knife can also lend a hand.

The next step called for greater effort. The soil had to be tended more carefully, to save the topsoil from being washed away during heavy rains. In many places earth dikes were built on the sloping banana plots and planted with grass or bushes that could be

Banana plant stem sliced through at the root The dark patches mark the boreholes of the banana beetles, which have all but destroyed the plant

At a meeting of the banana growers' credit union at the home of one of its members, the agricultural commissioner for the area is making a speech about the excellent results

cut down and scattered over the soil to supply nourishment. There are not many cows in the banana-growing districts, but still there is some manure. Mixing this with agricultural waste produces in just a few months a splendid compost, which, as a fertilizer, really can be beneficial.

The third improvement involved ridding the plants of the fungal growths. This is done by placing new shoots in water, gradually heating them to a temperature of exactly 52°C and keeping them at that temperature for half an hour. This does not harm the plant, but it does kill all fungal growth. While this technique is beyond the means of the individual farmer, agricultural advisors located here and there throughout Uganda do possess the necessary equipment and pass it on from one place to another at regular intervals. It is obviously a lengthy and complicated process, and still only in its early stages.

The weighty new bunches have made this farm worker's job even harder. Fortunately, though, they have also provided work for more people.

Together, these three methods have made a real difference.

But the real trump card came as the result of many years' work in the laboratories of the banana and plantain research center, International Network for the Improvement of Bananas and Plantains, and in IITA's own test fields in various parts of Africa: new strains capable of warding off disease and insects almost unaided. Not only that, but they will continue to thrive even when there is a dearth of rain.

The sturdy bicycle

The strongest arguments for these new methods, however, are the huge bunches of bananas thus produced. Daniel Rwaheru has taken the eldest of his 10 children out to the plantation to cut down a bunch. He tests the weight with his little spring balance and it gives a loud creak. Previously, a bunch weighing 20 kilos was a rare occurrence. Nowadays the average weight is almost double that, and he has had the odd whopper that tipped the scales at 45 kilos.

At the research station, where the plants are tended under strictly controlled conditions, they have been known to yield bunches that weigh as much as 65 kilos. Many banana palms have to be propped up with forked sticks to save the stem from cracking. It is a tough life being a fully laden village bike in this part of the country.

The marvellous thing is that the strains that give the greatest yields are also the ones best able to withstand attack by disease and insects.

Work and teamwork

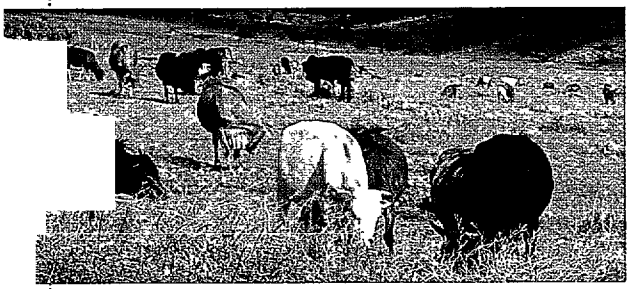
The farmers do not achieve such good results by lying down on the job. Tending one's plantation according to these new methods means putting in a lot of extra hours. According to Daniel, one result with which he is especially pleased is that he is now working full time on his own land and does not have to take a job in the village. He used to work part time as a bicycle mechanic, but these days he has more to do at home, and there is good money in it.

And a fair amount of time has to be devoted to the credit union, which also functions as a kind of banana growers' club where helpful hints are passed on and ideas exchanged, and where researchers and agricultural advisors hold courses. Further work has to be carried out on more of the 22 varieties of banana that have excited the researchers' interest. Cultivation methods can be improved, and it is expected that it will be possible to develop plants capable of withstanding other banana diseases – ones that have not given any trouble so far but could do so at any time.

For the moment, however, a relatively unconcerned Daniel Rwaheru trundles along the dusty red dirt track with his heavy load of bananas. The front wheel never leaves the ground. But that is only because the bike is a good make, going appropriately enough by the name of "Hero."

Blue and black lord of the flies

● *Ethiopia*
● *Kenya*



The herds of cattle are driven out by the cowherds to graze on those stretches of land where the soil is unfit for crop growing

In the days when God was more than a little displeased with the Egyptian pharaoh for not allowing Moses to lead his people home to Israel, he visited the Egyptians with his 10 notorious plagues, one after the other. And in the end, after suffering pestilence, an overabundance of frogs, and hail, they knuckled under.

But had it been the peoples to the south of Egypt, where Nature is of a different order, who had been so wayward, God would no doubt have unleashed the tsetse fly. In this case he probably would have been able to make do with just one plague. Not only is this gray fly a nuisance, it also transmits potentially fatal diseases to both humans and cattle: in human beings, sleeping sickness; in cattle, trypanosomiasis. In both cases the victims are rapidly sapped of strength; some die within a very short time, others grow weaker and weaker before finally succumbing to pernicious anemia after a year or so.

But if God were in need of an effective plague today, in Ethiopia or Kenya for example, he might be less likely to think in terms of the tsetse fly Because from heaven he now looks down on landscapes dotted with the little blue and black fabric screens that are driving back the tsetse flies.

A costly battle

The name tsetse was given to the fly by the Zulus of South Africa, in rough imitation of the sound made by its whirring wings. The flies themselves are not poisonous. But they bite, suck blood and thereby transmit, from the sick to the well, a parasite which then enters the bloodstream. There are two different parasites for humans and animals, but the result is the same. The flies inhabit brushland that is often close to water. These are often the very spots that are ideal for farming. The flies have been put to flight in quite a few areas, where the brush has been cleared to make way for fields. But all this does is push the problem aside a bit, since the lands adjoining the bush country are still afflicted – and the tsetse can fly a long way.

One option would be to try spraying with insecticide, but this remedy is fraught with problems. Friendly insects, such as the honeybee, are killed off at the same time; and poison is after all poison – harmful also to human beings. Not to mention the cost: around $100 a year per square kilometer and even more for spraying from the air. The tsetse fly is prevalent over a broad belt stretching across Africa from east to west: 10 million square kilometers, an area bigger than the United States. Even though not every single spot has to be sprayed, it is a hopeless course of action. In those places where it has been tried, the benefits have been short-lived.

Sleeping sickness can be treated with drugs, but it is expensive. In Kenya a full course of treatment can cost as much as US$50 per person, slightly more than parents pay to keep a child in grade school for one year. Nonetheless, efforts to drive out sleeping sickness have at long last proved successful wherever a fairly smooth-running health-care system is in operation.

The chief problem today lies with trypanosomiasis in cattle, and domestic cattle in particular. The prescribed treatment here, a course of four injections, is difficult and expensive – about $17 for the full course. Cattle are a vital element in the agricultural system in large areas of Africa, and in many districts all the cattle from one village will be driven out to pasture in one large herd. It could not be easier for the tsetse fly, and the cattle can hardly help but be infected at some point.

Turn tail and run

Forty-odd years ago, the tsetse fly established a firm foothold in the Goreda region of central Ethiopia. Goreda borders the vast basin of the Rift Valley, its rivers and lakes fringed by all the brush a tsetse fly could wish for. So well did it thrive here that all attempts at farming had to be abandoned and men and cattle quit the area altogether.

At around the same time, the same thing happened in the Lambwe valley in western Kenya. Wildebeest, buffalo, antelope, and gazelle were able to lay claim once more to their old territory. In neither place did this prove a tenable solution: throughout the region the population continued to grow, and it was hard to turn one's back on land that could be farmed.

Catch those flies

As far back as colonial times, in various places throughout Africa, people experimented with catching the flies in insect traps. These were not particularly effective and were horrendously expensive. The earliest traps cost over $450 apiece – and there had to be plenty of them.

ICIPE, the International Centre of Insect Physiology and Ecology, which has its headquarters in Kenya, began working on tsetse traps in the 1970s. Their researchers studied the tsetse fly from all angles, to the point where they knew almost everything there was to know about its three-week life span, its bloodsucking, and its flying technique and hunting habits.

All of this information was essential in order for them to come up with the blue and black screens that can now be seen dotted about the bush at 200-meter intervals in many locations throughout Africa.

A need for simplicity

Researchers knew that the tsetse fly could spot an animal at a distance of over 100 meters, due to the way the sun's ultraviolet rays reflect off the hide. They wanted to reproduce this effect, and so in West Africa they tried stretching fabric across a frame. They bought what they could find in the local market, where the most common fabrics were some pretty blue cottons printed with a black pattern. Blue proved to be – quite literally – dead on target. The flies spied it from a long way off, and homed straight in on it.

Once the flies came closer, it was hoped that they would mistake the fabric for a nice, tasty cow, and here scent played a vital part. The scent of nail-polish remover, acetone, worked well. The only problem is that it is expensive, and it evaporates in no time flat. After several other

liquids had been tried, the solution turned out to be urine from the cows themselves, which was most effective after it had been left to stew for a few weeks. This was poured into a can with a small hole in its lid and would emit a fragrant odor for several weeks before having to be refilled. Bon appetit!

A length of blue fabric was stretched across a V-shaped arrangement of poles. A piece of black material was then strung across the crook of the V to form a triangle and the open top of the triangle closed off with a pyramid of white mosquito netting.

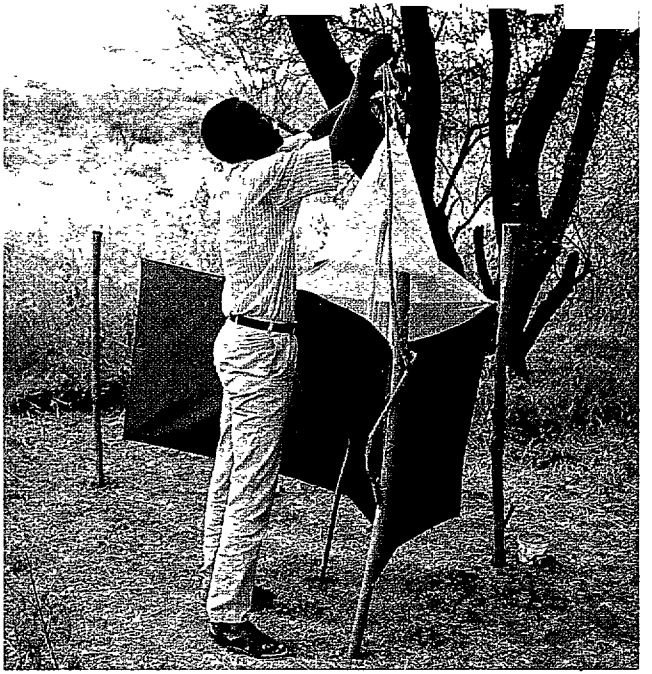
The idea is that the flies land on the trap, crawl about trying to find a good spot to bite, and sooner or later find themselves inside the triangle, where it is dark. The flies instinctively head upwards toward the light, and *voilà*, there they are, in the mosquito net.

The net acts as the trap's sluice, containing as it does a small opening into an ordinary clear plastic bag. To the tsetse flies this may look like an escape hatch, but in the blazing sun it spells certain death within just a few minutes, because there is no way back. Interestingly, only the most troublesome species of tsetse fly gets caught, and no other insects. And oddly enough, female flies carrying eggs do not enter the trap. But their offspring *do* end up there in due course.

Tremendous results

Over the past 10 years people have been moving back to the Lambwe valley. When the first traps were set up an average of 200 flies per day were being caught in each trap. Eight months later so many had been caught that the figure had fallen to one fly per day!

It is the same story in Goreda. Ninety-nine percent of the flies have been exterminated. This has been done by positioning the traps close together around the river margins and in the densest brushwood and distributing them more widely higher up the valley. Goreda did not become involved in the project until 1996, and one year later, for the first time, grateful returnee "settlers" plowed fields that had been fallow for 20 years. And, after many years, young cowherds are once more driving the cattle down the slopes to pasture every morning and up again every evening.



In southern Kenya the Masai, formerly a nomadic people, have settled in the Nguruman area to become vegetable growers, their crops watered by the streams that run down the slopes of the Rift Valley. But they still keep their cattle out on the plain. Neither animals nor people could survive without the fly traps. Today Nguruman is, by local standards, a prosperous community exporting aubergines, chilis, and other "Asian vegetables" to a large Middle Eastern market.

Good and cheap

In a little demonstration held in the Lambwe valley's cramped, mud-walled meeting house it took farmers just 15 minutes to put together a trap, using thread and a staple gun. The poles had been cut from the bushes in which the traps were to be positioned. Fifteen trap associations have been set up in the valley and over 60 of the 625 members have attended training courses, so they know just about everything worth knowing about tsetse flies and

The tsetse-fly traps must be tended, if possible, twice a week. Any longer between checks and animals may have knocked over the traps and the plastic bags may be full of dead flies.

traps. The men and women who have been trained deliver most enthusiastic talks, for the benefit of visitors and one another: on the biology of the flies, on the disease, and, not least, on looking after the traps.

Outlays have been reduced to approximately $10 per trap. But even this still constitutes something of an expense, because in this valley alone almost 500 traps have been set up in the 100 square kilometers covered.

The trap associations scraped together the money for about 150 traps. ICIPE and their Kenyan and foreign associates paid for the rest. Since 12,000 people now live in the area, with more than 22,000 head of cattle, that is almost two per person.

Minding the traps

In Goreda they also know their stuff and can produce a trap for roughly $9. They only started 18 months ago and there is more than enough to do, with tsetse flies rife in an area covering upward of 600 square kilometers in which the population has now grown to a total of 143,000.

One problem common to Lambwe, Goreda, and Nguruman is that it is not simply a matter of clearing some space in the dense, thorny bush and setting up traps. These traps have to be maintained. This presents plenty of problems, and some ingenious solutions. In Nguruman the ants take great delight in gnawing through the fabric, but they can be kept at bay by covering the lower halves of the poles supporting the trap with grease. The monkeys would like to get their hands on the tasty tidbits in the plastic bag: for them it's like having their dinner handed to them on a plate. But coating the lip of the plastic bag with a mixture of chili powder and grease makes even the hungriest baboon keep its hands to itself!

Unfortunately, the blue cotton is also exactly the right material for the school uniforms in some of the villages. So there have been no small number of thefts. This problem is solved by making a few snips in the cotton. The trap is none the worse for these, but no decent shirt could ever be made out of that material. The larger wild animals tend to knock traps over when prowling around the area, and rain and flooding can leave the fabric spattered with mud, in which case it has to be brushed clean or replaced. The traps must be inspected regularly. In Goreda they manage this by having the young cowherds check the traps each day when they are passing by with the cattle. In Lambwe members of the trap associations take turns fighting their way through the bush – barefoot, mostly – twice a week. In Nguruman they only inspect the traps once a month, as can be seen from the heavy plastic bags, their bottoms thick with black fly corpses.

Is it viable?

Inspection once a month is too seldom, something the people of Nguruman have realized. They are currently in the process of setting up an association similar to the one in Lambwe. In Goreda they already have theirs up and running.

The plan is for ICIPE and their associates to pull out of the project gradually. In Lambwe the process of withdrawal is well under way, but both there and in Nguruman this has taken some time, due to the breakdown of the first trap associations. Now things seem to be on a more stable footing. But for the next few years it could well turn out to be a case of two steps forward and one step back. Now, when the tsetse fly problem has all but died down, one could envisage that people might start to relax and more or less forget about minding the traps. But this would open the way for a fresh influx of flies from neighboring lands.

However, it is hoped that in the years ahead life will become so much better than before the traps were set up that the little communities will have enough in reserve to strike back hard themselves, should the tsetse plague build up again. This work is being followed with great interest by researchers and agricultural advisers in other parts of Kenya and Ethiopia and in neighboring countries, where they are all set to adopt the system.

Now the potatoes are shooting up

Ethiopia

Zegeye Watiyo was doing well as a farmer even before he took to producing seed potatoes. He had four acres of land and two dairy cows and two oxen working his fields. The agricultural potential in his part of Ethiopia – the Shashamene hinterland, about 250 kilometers south of the capital, Addis Ababa – is good.

Zegeye is fortunate in other ways, too: he attended school for 10 years and is blessed with a very small family, by local standards – just three children And no plans for any more! At 27, he is already a respectable pillar of the community. He is now taking part in an experiment aimed at boosting agricultural output, initially in his area, with hopes of expanding the program throughout the country later on

When test results from the laboratory are put through reality checks in the fields it is essential to have the support of intelligent, clear-sighted individuals whom other farmers look up to. Zegeye was an obvious choice

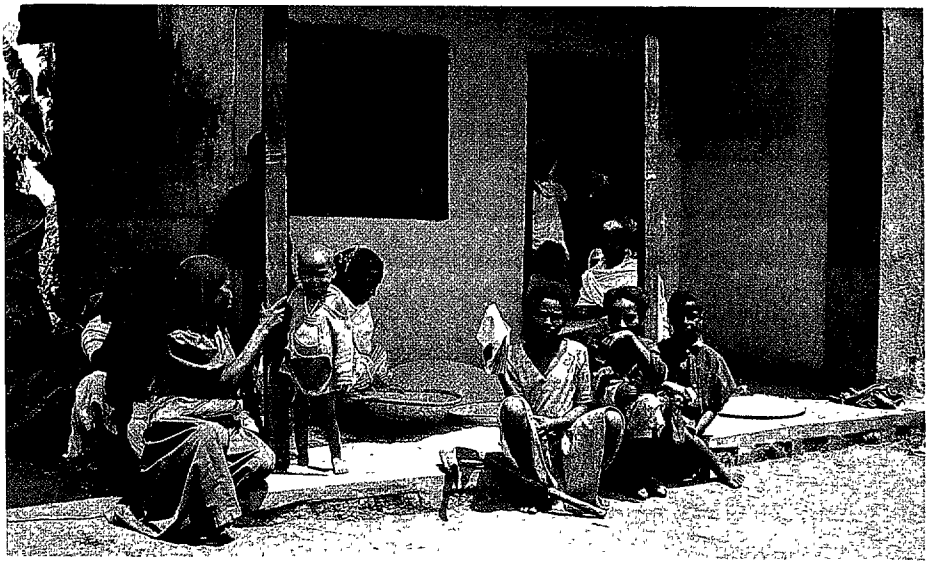
Too few potatoes

The issue is seed potatoes, but at this point, potatoes play little part in the Ethiopian diet. That is only because so few of them are produced here. The demand for good potatoes is considerable, and a price of more than half a birr per kilo for good potatoes is not uncommon in the local market. And we are talking of the provinces here, where the monthly salary of a well-paid public servant, a watchman with many years' service under his belt, does not exceed 230 birr. (A birr equals about 15 cents.)

A good crop of potatoes can outdo almost all other crops, even grains, when it comes to calories per acre And the per capita calorie intake in Ethiopia is not very high, even if times are relatively good. Every family could do with a bit more food in the pantry, and the population rate continues to grow. So good seed potatoes are something they cannot have too many of. Over the years, the local potato varieties – introduced in the 1880s – have

In an advertising campaign, this could stand as the BEFORE shot, depicting as it does a variety of potato that has been infested by insects. The story beneath the soil is just as depressing

The household budget of a well-to-do farmer in Ethiopia also has to provide for relatives and neighbors. Much of the work around the house is shared and all the helpers have to be fed



been stricken by disease and degenerated drastically. Farmers have been in the habit of setting aside the sub-standard tubers for use as seed potatoes, with poorer and poorer results. Viruses and mold make for a crop that is even more feeble, and stockpiled potatoes are attacked by insects.

A slow start

In the late 1970s the Ministry of Agriculture and CIP, the International Potato Center, located in Peru (the home of the potato) began a collaboration in which CIP supplied a number of newly-developed varieties for testing. Any warrantable test will take six or seven years to complete and the first two varieties, selected from among a great many samples, were introduced in 1986 and 1987, respectively. While these showed promise at the research stations, potato blight nabbed them in the fields and that was the end of that trial.

Researchers distributed the next batch of new varieties to the test farmers in 1991 and, since then, a total of five new strains have been singled out as suitable for different soils and different climates in Ethiopia. An interesting selection of varieties, as it turns out, giving a yield up to three times greater than local varieties under identical growing conditions.

Planning ahead

Which brings us back to Zegeye. In 1995 the Ministry of Agriculture initiated a special program for the improvement of potato production. Shashamene was chosen as a test area, with CIP and two large private organizations, Japan's Sasakawa and Global 2000 from the United States, collaborating on the project. CIP agreed to provide new, improved varieties and advice, Sasakawa/Global 2000 would inject some capital into the venture, and the Ministry of Agriculture would select and organize the farmers.

Zegeye was one of 12 well-educated farmers from his area who, in 1996, attended a two-day course held at a research station 350 kilometers to the north. As early as July, with the long rainy season well under way, the 12

Here we have the AFTER picture from the advertisement: the new varieties – tended correctly – produce healthy plants and large potatoes that keep well.

selected farmers planted the new strain of potato. They were to give over at least two-thirds of an acre to it, which may seem like a big risk for a farmer with only 3 or 4 acres, but past experience with the Ministry's advisers was positive, and so the farmers trusted them.

Never seen the likes of it

Neighboring farmers inspected the test fields closely. Why did the potatoes have to be laid in rows? And was it really necessary to "earth up" twice, and so high up round the plant?

The guinea-pig farmers did not really have the time to worry about such questions, because they had enough to do just remembering all the new things they had been taught. The soil also had to be treated with fertilizer, not, as was usually the case, spread by hand across the field, but sprinkled in small quantities around each plant

Preparations for the harvest kept them especially busy, as did building storehouses for the seed potatoes. little wood-frame huts with corrugated-iron roofs and walls of dark, fine-meshed netting. Inside the huts were large shelving units with plenty of space between each slatted wooden shelf and the one above. This kind of storehouse provides protection from the sun and blocks out a lot of light, and with only three or four layers of potatoes on each shelf the ventilation is excellent. Such conditions are ideal for the development of shoots for next season.

The harvest in November was a strange affair and once again all eyes were on Zegeye and his fellow test farmers when they went out to cut off the potato shaws just before harvesting. The potatoes were left in the earth for a couple of weeks to inure the skin against bruising and insects. They had never seen anything like it in those parts. But the potatoes were wonderful, and there were lots of them.

More than breaking even

But from then on nothing was free. The seed potatoes had been given to the test farmers as a loan, the agreement being that they would hand back precisely the same number of potatoes as they had been given. Granted, they had built the storehouses themselves, but they had borrowed the money for the building materials: 2,000 birr, which is not exactly peanuts. One third of this had to be paid back after the first harvest. The fertilizer had also been purchased with money borrowed from the Ministry, and now the time had come to settle up. Even so, they made a profit. Their neighbors were all but queueing up to buy the new seed potatoes – at a price per kilo that was almost twice as high as that for household potatoes.

The yield was, as promised, more than three times that of the previous season. While the new varieties are intrinsically better, much of the credit for the good harvest is due to sounder advice: more space given to each plant; precise

doses of fertilizer; two, and preferably three, earthing-ups in order to smother weeds and prevent insect attacks at the base of the stalk, the most vulnerable point.

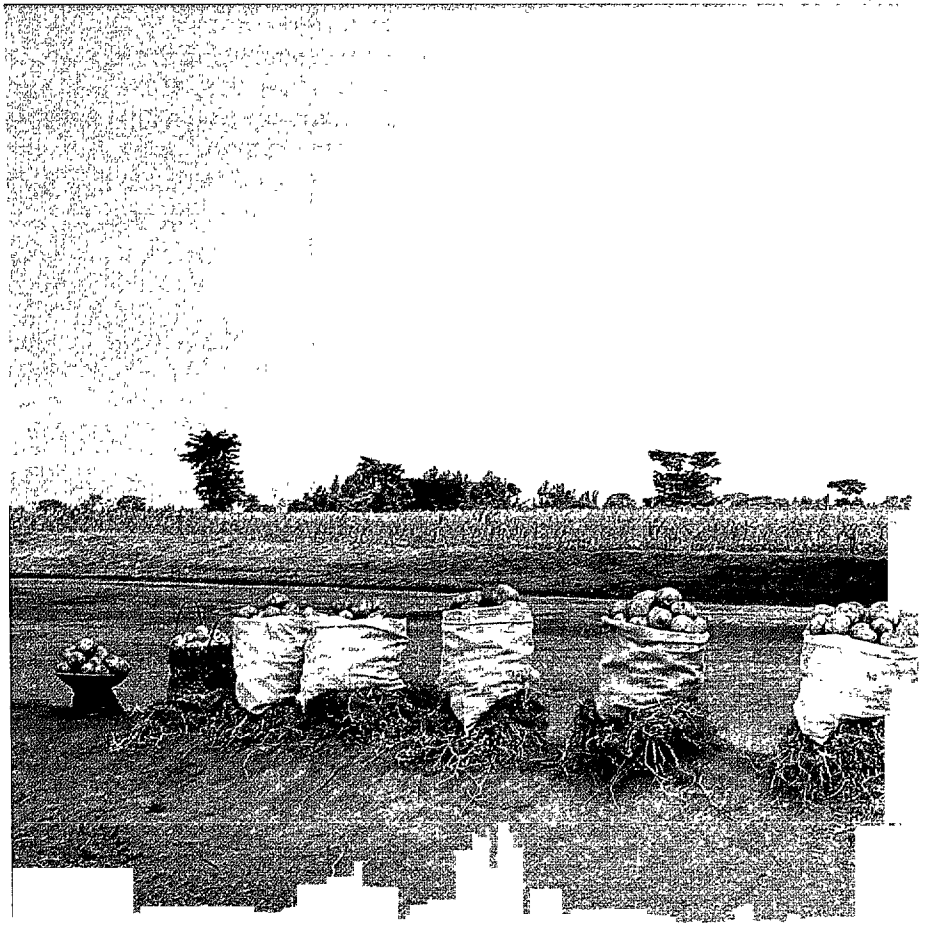
And what about problems? Zegeye cannot really think of any. The new plants are not subject to potato blight – you only have to compare an ordinary field with a test field to see that. Nor have they seen anything of the accursed potato tuber moth, which works its way into the stalk and from there into the potatoes, leaving them more or less hollow, if given enough time after the harvest. For this they have to thank the thorough earthing-up process and one round of spraying with insecticide. But only one round, and only at the right time.

The farmers are taught the spraying technique on their training course, and they spray under supervision, using Ministry of Agriculture equipment. Everyone knows it is not the healthiest activity, but the only protection they can afford is a large bandana to cover the mouth. A suit of protective clothing and gloves costs at least 500 birr and would only be used twice a year. Other farmers lose a lot to the potato moth – either that or they spray on and off throughout the season. This is both expensive and bad for the environment.

From strength to strength

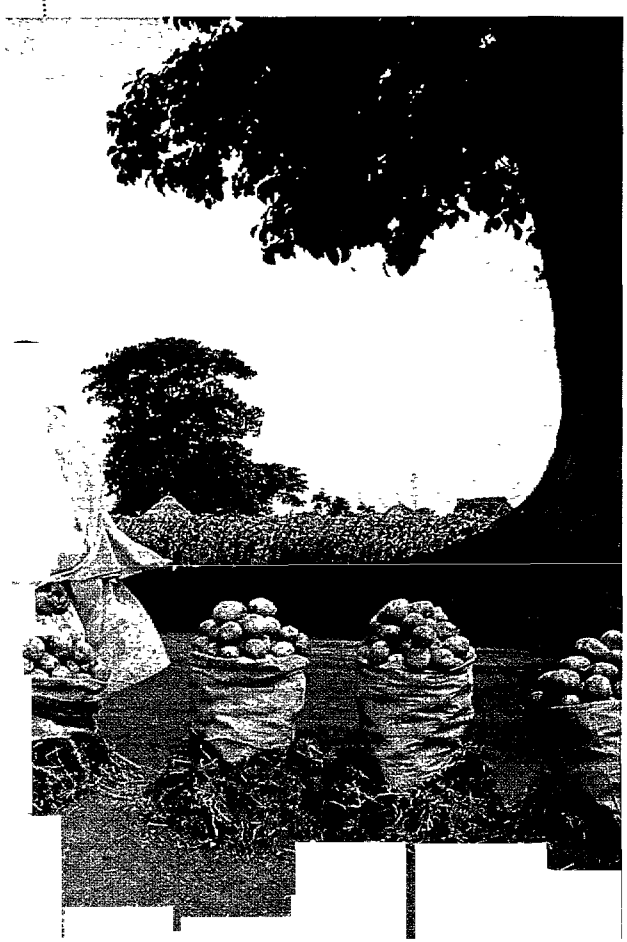
By February 1997, the seed potatoes were ready and were duly distributed to 12 new farmers, making a total, according to the official record, of 24 participants in the scheme. But another dozen farmers had latched on to the idea, bought the new seed potatoes, and fitted out storerooms for them. By June all 36 could feast their eyes on beautiful green potato patches, nearly ready for harvesting.

Both experienced farmers and new hands spent one day midway through the season on a joint training course. This time a number of high-ranking experts were also in attendance: now the researchers were going to learn from all the good advice the experienced test farmers could pass on to the first-timers and the specialists. One point that came up was that they would have to have new storehouses to hold the household potatoes, because at the rate things were going, there would be a whole lot of them. As



things stand now, the potatoes are kept stacked up in a corner of the farmyard, where they slowly molder away. The pioneering farmers are growing seed potatoes for agriculture, while the conventional farmers are producing potatoes for the housewife.

Like most farmers, Zegeye is cagey when it comes to quoting exact figures on income and profit. But he is happy to show us the plot of land he has purchased in Shashamene town, so that he and his family can be better placed once all three children start school and – who knows – perhaps even go on to high school. There is always the possibility that they will not want to go into farming. A newly-built house – a little on the modest side, perhaps – already occupies the site. Zegeye explains that he is planning to build a larger one soon.



For Zegeye and his colleagues this scheme has been an unparalleled success. In November 1997 another 12 potato growers joined their ranks; in 1998, two batches of 12 and so on. And it is all virtually free: the loans for the storehouses are recycled, and the seed potatoes paid back. The experienced farmers teach the new hands, thus keeping the costs of the training courses within the vigilant Ministry's budget.

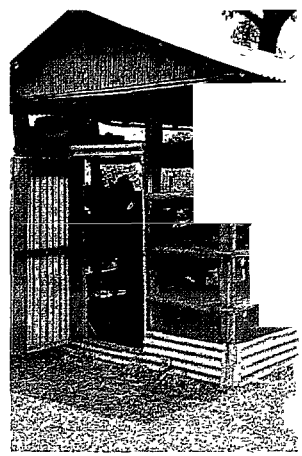
However, the real success cannot be measured until the figures start to speak for themselves. Ethiopia produces a mere 350,000 tons of potatoes per year, and this amounts to no more than an average consumption of 6.5 kilos per person. Uganda, which also spreads across the equatorial uplands of East Africa, supplies 17.7 kilos per head.

But, efficient as they are, the people of Shashamene do not have to go it alone. The potato research center in Peru has been monitoring the experiment closely and is all set to move on to the next stage New varieties are continually being developed, including strains capable of coping with other hazards and guaranteeing the revitalization that prevents inbreeding.

All in all, the project has cost approximately $30,000 This does not include all the time and effort that have gone into developing those good, high-yielding, hardy potato varieties – work running into hundreds of thousands of dollars, and all carried out by CIP and local researchers. The international community has been contributing to the cost of developing potatoes for Third World countries since 1971. Clearly this is an investment that is already paying dividends not only in Ethiopia, but in many other parts of the world as well.

Potatoes are sold at the roadside to visitors from the city, fetching a good price and providing the villagers with a bit of extra cash

Home-built storehouse to hold the sprouting seed potatoes An airy construction, the dark netting provides good protection against sunlight and pests



MINING THE SOIL

Many developed countries are faced with environmental problems caused by excessive use of fertilizers. In most African countries the exact opposite is the case. Poor care of the soil and inadequate topdressing leads to environmental damage and depletion of the nutrients in the soil. This in turn results in low or falling agricultural yields and consequently a less reliable food supply.

In order to grow, plants require air, sunlight, water, and nutrients (especially nitrogen, phosphorus, and potash). Unless a certain balance between the various nutrients is maintained, growth will be impaired or the plants poisoned.

Some of the nutrients in the soil are lost when the plants are plucked at harvest-time.

The key thing then is to re-establish a healthy balance. It is possible to apply too much fertilizer, which makes for inefficient farming – and may even damage the environment. But it is also possible to put back too little, in which case the farmland is exhausted and the topsoil ruined. African farmers have traditionally had several ways of ensuring the nutritive balance of the soil. They shifted the locations of their fields, clearing the way for new ones by burning down brushwood and trees. Or a piece of land was left fallow for a few years in order to allow the weeds to grow and rot and thus inject fresh nourishment into the soil. It has also been common practice to grow plants that would protect the soil, by sheltering it and preventing heavy rain from leaching it of nutrients. Other methods have included the spreading of compost, mulch, and animal manure and the growing of a mixture of crops in one field to prevent an unequal draining of the nutrients in the soil.

These methods were sound enough, and quite appropriate, as long as there was enough land to go around. But, due to the drastic increase in population, land is now in short supply in most parts of Africa. Between 1980 and 1993 the area of cultivable land per capita in Africa south of the Sahara dropped by 24 percent. Almost everywhere it has become necessary to supplement the old methods with fertilization of the soil to avoid falling agricultural yields.

However, the African farmers use incredibly small amounts of fertilizer. In 1993 only 15 kilos were used for every hectare of cultivated land, and only 10 kilos per hectare outside South Africa. In Asia, in the same year, the corresponding figure was 118 kilos, with an industrial country like Denmark employing as much as 191 kilos. And consumption in Africa has hardly risen at all over the past 10 years: by only half a percent per year, in fact, while a significant increase has been shown throughout the rest of the world during the same period. In Africa, less nourishment is put in than is taken out through cultivation – what is known as "mining" of the soil. The average annual loss per hectare of land works out to be 22 kilos for nitrogen, 2.5 kilos for phosphorus, and 15 kilos for potash.

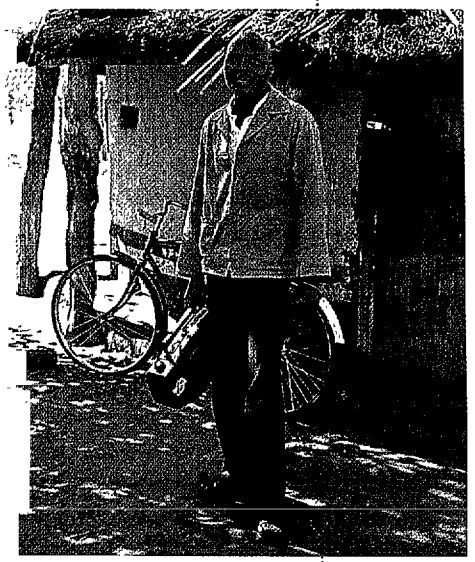
There are many reasons why so little fertilizer is used in Africa, the main ones being that

- the importation of fertilizer is expensive, due to shipping costs;
- there is lack of foreign capital to pay for fertilizer;
- distributing the fertilizer in the various countries is no easy task;
- the cost of fertilizer is high and farmers' selling prices are often kept artificially low by government regulations;
- often there is a shortage of sturdy varieties that can benefit from the extra fertilizer;
- it is not easy to obtain a loan to buy the fertilizer; and
- uncertainty regarding ownership of land often reduces incentives to improve land that might be taken away from the farmer.

For anything constructive to be done about the problems of soil exhaustion, all these issues will need to be addressed. In sum, the policies of the countries themselves, agricultural research, and foreign aid can all play an important part in turning the tide.

Millet – more than just bird seed

Zimbabwe



Mr. Nkomo earns a nice profit from his new millet. Improved farming methods have clearly enabled him and his family to get on top of things

Disco music is not exactly what one expects to encounter when entering the grounds behind the palisades of a family compound in the extreme west of Zimbabwe. But Alaster Nkomo's big cassette player is blaring mightily as he greets his visitors outside one of the many houses set around the compound, and his mood is every bit as upbeat. His wife, Sifiso, is also very happy to show the place off and describe how exceptionally well the large Nkomo family has been doing over the last couple of years.

It all began in the spring of 1992, when she and other village women were invited to a meeting at the Matopo research station. It is here that ICRISAT – the International Crops Research Institute for the Semi-Arid Tropics – works in conjunction with local agricultural researchers on the development of new plant varieties. The researchers offered to give the farmers' wives samples of mature millet plants and they were given their pick of five new varieties that were ready to be released in Zimbabwe. They all pounced on one particular variety and the small test field was totally stripped of millet cobs.

Sifiso managed to lay her hands on a single cob, covered in ripe pearly seeds, and she did not loosen her grip on it for one minute of the 100-kilometer-long drive back to her village near Tsholotsho, where she promptly made a start on her own small millet crop. The start, too, of an honest-to-goodness success story.

A long journey

For the researchers this story began many years earlier in quite a different part of the world. Like other international research centers, ICRISAT is continually collecting plant samples in order to analyze them and possibly develop new varieties. In 1980, on a research station in Burkina Faso in West Africa, ICRISAT carried out some growing trials on a variety of millet taken from the neighboring country of Togo. It did not look like much, but it had one distinct advantage: the seeds were ripe three months after sowing.

There are many places – not least of all in Africa – where this particular quality is vital, and so the researchers sent some seeds from the station to ICRISAT headquarters in India. Here, the plant was analyzed in depth, subjected to further growing trials and crossed with other varieties.

In 1987 ICRISAT dispatched 50 different varieties of millet to its research program in southern Africa, among

them the selected hybrid from Togo. One of the countries taking part in the ICRISAT program, Namibia, was eager to try out a few of these varieties and a growing trial carried out in 1987-88 convinced local farmers that there was something to be said for the Togo strain. Still going under the rather uninspiring label of ICMV 88908, it was all ready for launching during the 1989-90 growing season. Of course all of this took time; good solid crossbreeding work always does. In fact in this case they had cause to congratulate themselves on the fact that it had taken no more than 10 years; often it will take much longer, and not because of slacking on anyone's part.

Everybody's favorite

The farmers were asked to come up with suggestions for a more interesting name for the hybrid than the number employed by the researchers. So the millet was named "Okashana" after the Okashana research station in Namibia. There was general agreement, too, as to why the Okashana millet was so outstanding. It does well with only a limited amount of rain, and even in drought-stricken years will provide a fair yield. The grains are large by millet standards, and it gives a good crop, too, in years when there is plenty of rain: up to 70 percent more than the old varieties. Above all, as we have seen, it ripens fast.

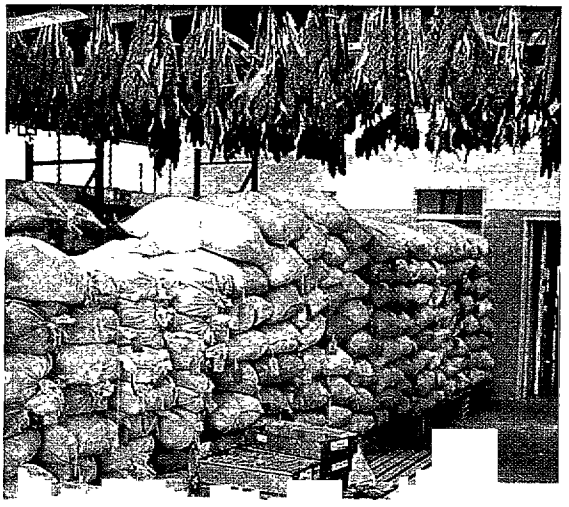
This last point is crucial in a part of the world where usually two out of every five years the rainfall is dreadful for farming. Too little, or too late; or too sparse, with long dry spells in-between. Going by the geography books, between the end of November and the end of March approximately 550 millimeters (21.67 inches) of rain should fall on the Nkomo family's fields. But things do not always go by the book, and that presents a host of problems.

The seed is not sown until the first rain. If it is late in coming, then it is good to have a crop capable of growing and ripening before the end of the rainy season. If the shortfall of rain is not much worse than average, it is good to have a crop that does not need as much moisture, due to its brief growing span. And if it has been a very bad year for rain, there is always the chance that the rains will come early next year, in which case a fast-growing crop will ensure that the storehouses will soon be seeing some grain again. In a really good year it is actually possible to sow and harvest twice, since the millet does not need rain in the very last stages of its growing phase.

Food in reserve

One of Nkomo's neighbors is rather late in threshing the Okashana millet she harvested in April. Now, in July, it has dried out completely and must be attended to while there is still a bit of breeze to blow away the chaff when the threshed grain is tipped from the plastic basin into the big zinc tub. The sweat flows freely on the large, fenced-in threshing ground. The mud floor is hard and smooth and a number of large flat pallets are piled high with millet and durra, another cereal that can cope with the dry climate.

Bigger harvests mean lots of extra work. But the storehouses ought to be stocked, if possible, with enough grain to cover a poor rainy season.



At the research station, the agricultural researchers have a large show storehouse, where the farmers can inspect the various varieties and take a free sample back with them to their own farms

Then there is a little maize, a few groundnut bushes, and some lentils that also have to be threshed, so there is still plenty to see to.

Many a zinc tub has to be hauled across to the storage huts, which have to be filled with enough grain to provide porridge morning, noon, and night for a whole year. This works out at well over a ton of millet alone for the Nkomos, with 16 mouths to feed every day. But the store is far from empty when the new harvest is brought in. No one would dare take such a risk when the rains are so unreliable. Much better to have enough to cover two years, to ensure survival should there be no harvest the next year.

Permanent state of crisis

Not a single year has gone by in Zimbabwe's recent history when there has not been a need for food aid as a result of a poor harvest in some part of the country. Researchers reckon that the new type of millet could constitute a strong weapon in the fight against crop failure, and if, as now seems likely, cultivation of this millet becomes more widespread, the government – or foreign aid agencies – will have to supply 10,000 tons less grain per year in the future.

It may come as a surprise to learn that, in effect, roughly a third of all the smallholders in the arid region of Zimbabwe can never produce enough food for their own family's consumption. And although nature may be less than bountiful, the main problem is that little has been done to help these smallholders produce more.

In those areas where the rainfall is somewhat better than out here in the west, maize is the vital main crop, and this has led to the development of numerous varieties of maize, all of which will bear a healthy crop in a good year. The small farmers in the arid districts have also gone in for farming maize, but the results tend to be poor. Before ICRISAT joined forces with the different countries in the region in the millet and durra project, there were not too many bright spots on the horizon for these smallholders.

Now a local newspaper airily flaunts the bold headline:

The Ncubes are proud of the progress they have made and would rather be pictured standing in the middle of their threshing ground surrounded by their fine harvest than outside one of the family's small houses.

"What hunger problem?" After all we've got the new millet! Nkomo's neighbor, Elvis Ncube, who was interviewed for the newspaper, thinks that was probably going a bit too far. But, as far as he is concerned, the thinking behind it is fair enough.

A better life

Elvis himself says that his own life is much more secure now. He can afford to send all of his children to school – four of the seven have so far reached that age – and all the family's day-to-day needs are covered. Their roving bank account, the herd of cattle and goats, has swelled over the past two years, with the addition of 2 cows, to a total of 15. And 3 of the 19 goats were bought not that long ago.

In fact there is good money to be made from having been one of the first farmers to switch to the new strains. Other farmers are standing in line to buy the seeds, since as yet no company is in a position to supply them. The businessmen have never really taken that much interest in the pittance to be made from the smallholders. So the Ministry of Agriculture is launching a new project that designates a number of villages as Okashana seed producers. The Nkomos' and the Ncubes' village is involved in the project. Everyone wants to be involved, because it pays. Anyone can see that.

The Nkomos' figures are solid. The first cob, picked up on that visit to the research center in 1992, yielded 30 kilos of millet, which were put aside for the next sowing, and that in turn produced seven 90-kilo sacks of grain. And that happened in a year when the rainfall was poor. One sack was set aside for seedgrain and the 1994-95 harvest yielded 33 sacks of millet. Of this, 23 sacks – upwards of two tons – were sold, and one sack exchanged for a fine black goat. The next year it was the same story, and a cow was bought with the profits.

As yet, no figures are available for this year's harvest, but it has been a very good one, and seven sacks of millet are already waiting for the cattle-dealer to turn up with the new cow that has been ordered. He is asking an additional 750 Zim dollars in cash. Nonetheless, Alaster Nkomo looks more than happy.

Perhaps best of all is the most recent development. A miller in Bulawayo, the main large town of the region, has discovered that town dwellers are also eager to make their porridge with millet. It is slightly cheaper than corn, it is tastier – and it just so happens that it is better for you. So the miller has bought millet from those farmers who have a surplus.

Both Alaster Nkomo and Elvis Ncube have sold some of their unthreshed millet. It is a great help to have such a buyer. In the old days, when the harvest was exceptionally good, a farmer could be stuck with the extra grain, simply because customers were few and far between.

Actually, Elvis does not have any Okashana this year. Instead, he has planted another good new variety, also a fast grower. But, as he explains: "everyone else around here is growing Okashana, and everyone has their own ideas about how their porridge should taste, so I don't think I'll have any trouble in selling my millet."

All in all, he is a shrewd man – still growing a few of the old strains, so that he will have them in reserve should new problems arise. Not only that, but he is planting closer together than before. He took a measuring tape along on his visit to the research station, and if the researchers can make do with only 75 centimeters (about 29 inches) between the rows, why should he leave the customary 90 centimeters (35 inches)?

The millet appears to have a lot of potential. And in the future, people abroad ought not to regard it as just bird seed. It looks far more like the difference between a life on the breadline and a decent living for small farmers in southern Africa.

Dairy cows under the coconut palms

Kenya

Nature endowed Kenya's long stretch of coastline bounding the Indian Ocean with sandy beaches, coconut palms, and some wildlife. These animals inhabited the brush and trees that form a border almost 40 kilometers long between the sea and the arid expanses of the savannah.

The coconut palms and the beaches are still there, but the wild animals have been driven inland and the brush has given way to farmland. So great is the population pressure in Kenya that every bit of land that can possibly be cultivated has gradually been pressed into service. Even though the soil here is sandy and poor, bit by bit it is being put under the plow.

This terrain is not designed for cattle, especially not dairy cows of European extraction. At least that was how the Kenyan government saw it until the mid-1980s. But the Ministry of Agriculture, local researchers, and experts from the International Livestock Research Institute (ILRI), decided to challenge such stick-in-the-mud thinking.

Now they can chew the cud

There are 10 dairy cows in the stalls of Katana Mashia's farm in the village of Bomani, north of the large port of Mombasa. And behind the lattice-work stalls three young cows with calves are tethered alongside four heifers and four bullocks. To do really well, the 13 cows need about 50 kilos of freshly-cut elephant grass a day, supplemented with various other types of fodder. But we will come back to that.

The calves graze on the piece of land surrounding the farmhouse, but they are not allowed to wander at will. That is part of the secret behind the fine balance that has been achieved in Katana's farming of the sandy soil.

That the researchers dared to experiment at all with a radically new way of thinking out here on the coast can be attributed to three factors in particular: in the first place, in a normal year the amount of rainfall was more than adequate, much the same as in northern Europe, except that it was concentrated in two rainy seasons per year.

Second, there was plenty of room for farming. In the 1960s, the government began to divide up the large expanses of uncultivated land and parcel it out in 12-acre plots to farmers. That is a lot of land compared with the 2 or 3 acres that tend to be the norm for the richer lands in the overpopulated regions of central and western Kenya.

And third, due to a major shortage of milk throughout the coastal region, supplies had to be transported the 500-odd kilometers from the heart of the country to a coastal strip that was gradually becoming more and more densely populated. Milk is an excellent cash commodity,

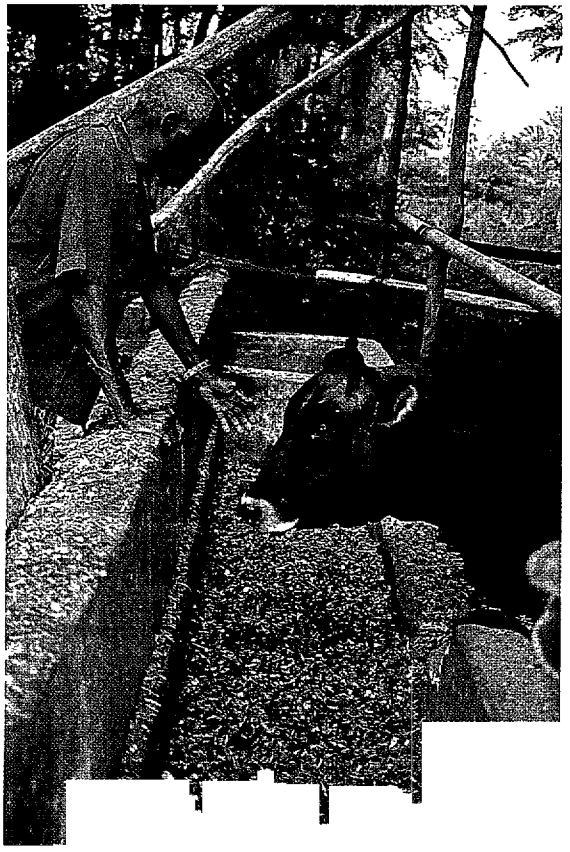
and on paper it seemed obvious that there was good money to be made if farmers could produce milk locally.

Problems aplenty

But Nature never intended it to be easy. The greatest hindrance to dairy farming was the cattle disease known as East Coast fever, transmitted by ticks which dig into the cattle's skin. Previously, up to one-third of the few local cattle died of this disease, while the rest became weak and yielded little.

Like other African countries, Kenya ran a program to fight ticks. At regular intervals, usually once a week, the herds of cattle were driven through a cattle dip containing a cocktail of chemicals against which the ticks could not survive. This remedy is still employed in many parts of Kenya, although it is increasingly regarded as an emergency measure, because of the obvious environmental hazards. Worse still, the ticks are gradually developing a resistance to the poison.

Another major stumbling block to cattle farming was the shortage of fodder. For cows to produce a high and consistent amount of milk – and, indeed, of calves – they need to be well-fed. And grazing among the coconut palms does not exactly fit the bill, especially during the dry months of the year. With big farmers one could simply have recommended that they bring in supplementary feed for their cattle. But such a suggestion was of no use to the settlers on the sandy plain. In spite of everything, the local cattle had the advantage that they could hold their own against some of the other diseases threatening the local livestock. On the other hand, even when they were well fed, they did not give much milk. If milk production was to be stepped up, new blood was needed.



The milk churns are washed and dried in the open air before being refilled and driven out to customers on the racks of the milk boys' bicycles

Good living conditions and plenty of fodder are to be had in the airy stalls on this well-run farm with the sandy soil

Another problem, of course, was that the coastal farmers did not know how to make a dairy farm on the standard 12 acres pay its way and support a family. But Katana Mashia demonstrates that there is no lack of willingness to learn something new, if there is some future in it. In 1989 he borrowed the money to buy his first two cows.

New cows

Katana would not have dared to risk making such a purchase had it not been for the fact that, back in 1988, the Kenyan Agricultural Research Institute, KARI – in collaboration with ILRI – had embarked upon a systematic charting of problems and solutions. At that time, working parties composed of researchers, farmers, local agricultural extension workers and representatives of private organizations in the region were established. It seems so obvious, but in 1988 – and still today in many places – the idea that researchers and farmers might compare notes and learn from one another's experience was big news.

It did not take them long to conclude that improved milk production was dependent on having a better breed of cattle. After a number of experiments they found that a crossbred cow of two-thirds European origin provided the right combination of high milk yield and a reasonable resistance to local diseases and the hot climate.

At the outset, the toxic cattle dips were the main weapon used against East Coast fever, even though this can prejudice the quality of the milk. However, the ILRI laboratories had been working for years on the difficult task of developing an effective vaccine against the fever. And a vaccine eventually was introduced onto the market, but with little success. It was too powerful, and, worse still, as many as one in eight of all cattle vaccinated died. Although better than one in three, this figure was still unacceptably high, and the whole concept of vaccination was dealt a hard blow, from which it took time to recover. Nonetheless, the researchers kept working on the vaccine and, since 1995, an improved version, which keeps the death rate below 2 percent, has been in use. Over 1,000 cows have been vaccinated and the independent veterinarians who carry out this work are constantly taking on new clients. Granted, a full course of treatment for one cow costs something like US$18, so the farmers tend to save up for a while and then have one cow vaccinated whenever they can afford it.

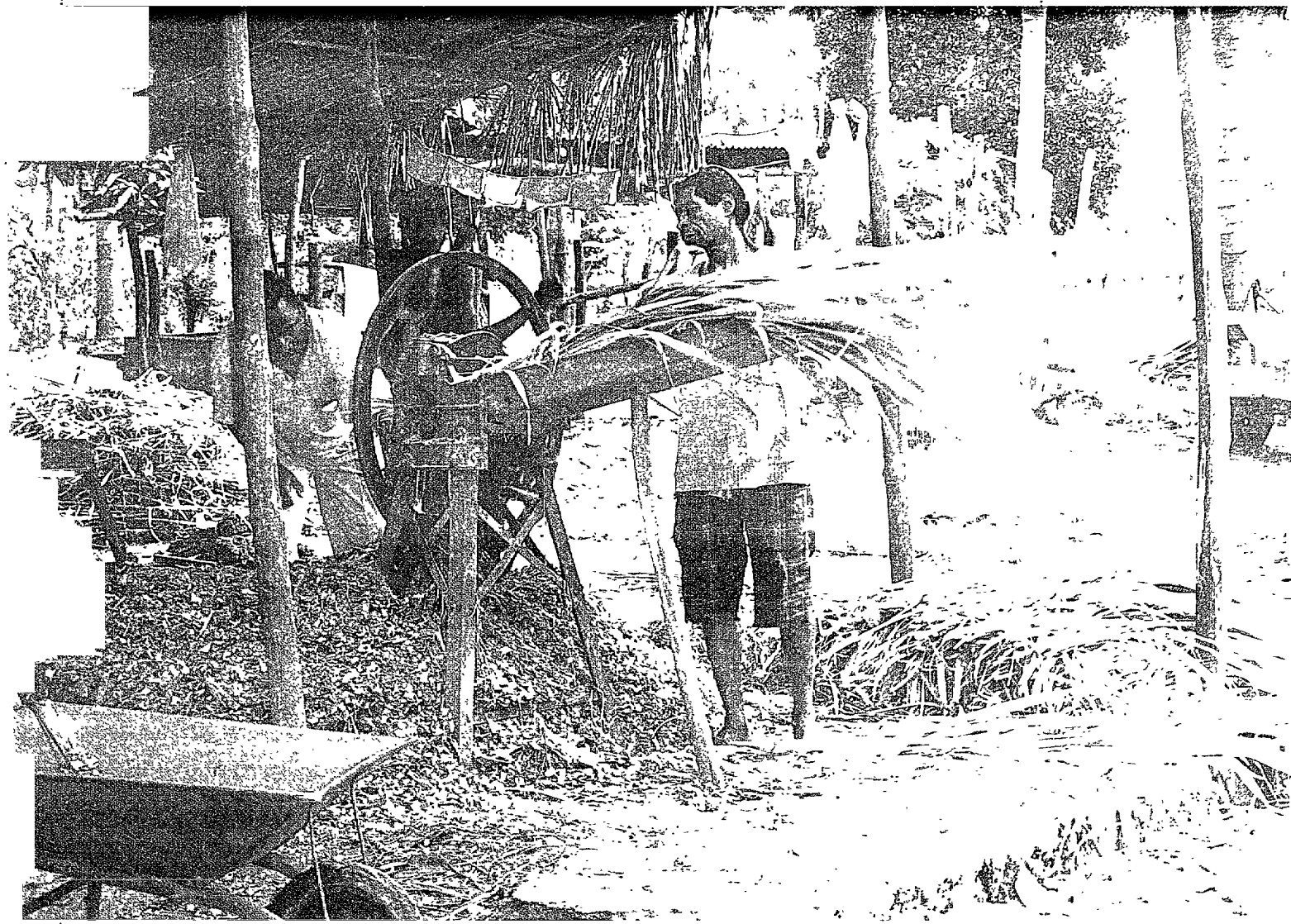
The chaff cutter is on the go for many hours every day, cutting the elephant grass into decent-sized mouthfuls for the cattle.

Katana Mashia wants to see how things go before having his cattle vaccinated, and so he uses another method, one which the researchers are not all that happy about. Every fourth week or so a splash of chemicals is poured from a pale-blue poison bottle over the backs of cows and calves. It costs him around $75 a month to treat the whole herd, but he hasn't lost a cow yet.

Zero grazing

Dairy farming also calls for good feed. From other parts of Kenya the researchers knew of some excellent grasses that grew fast and were packed with energy. But the growing of such grasses needs planning, and the cattle must be kept away from them initially, if they are not to be chomped down too quickly.

Napier elephant grass is ideal. It is left to grow to a height of about 1 meter, the point when the energy content is at its peak, and is then cut down to about 10 centimeters (about 4 inches). During the rainy season it can be cut again after a month, and every second month during the dry season. If – as in Katana's case – the planting has been properly planned, there will always be grass ready for reaping in one field or another. In addition, the grass has to be planted between rows of leguminous trees. All trees of this sort deposit a large amount of nitrogen in



their leaves, which are fed to the cattle. The nitrogen aids digestion, enabling the cows to gain the full benefit of the nourishment contained in the grass.

Katana Mashia grows elephant grass on 7 or 8 of his 12 acres. In most rows the trees are cut back to a height of half a meter, from where they will shoot up again even

more vigorously. But a handful of trees are left to grow, and so far these have provided the timber for three of the houses he has built on his land for his sons and their families.

Now that the long rainy season is almost over, harvesting of the elephant grass is about to begin in earnest. It is laid in sheaves in a large pit in the sandy soil and mixed with crushed sugarcane from a sugar factory, to make "grass jam" or silage as it is called – a good fodder supplement during the dry season. If the next rains come when they are supposed to, the cattle will do just fine.

Throughout the year, the cattle's diet also includes some maize cobs, and Katana also grows beans as supplementary feed. But the maize stalks and other agricultural waste is left in the fields: the soil must reabsorb nutrients if the crops are to go on flourishing. Still, the key factor here is the manure from the cattle. And there is a lot more than a drop in the heavy plastic buckets that the stable boys lug down the long paths through the fields. With that sort of a load, 12 acres is a lot of land!

Work for many hands

Katana's large team of workers carry out all manner of farm work. Most of their time is taken up tending and feeding the cattle, cutting grass, and cleaning out manure. But grain and vegetables are also grown on the farm, because the main priority for every farmer is to provide enough food for his own household. And with so many head of cattle and the substantial quantities of manure thus produced, there is also a surplus of maize, which can be sold.

Three young men are detailed to take care of milk sales. At the moment there are almost 100 liters of milk to spare each day, once the four families on the farm have had their share. This is loaded, in milk churns, onto the back of a bicycle, and the milk is sold door to door to families living near the highway. There is more money to be made this way, approximately 60 cents per liter, than from the dairy. Even after the herdsman, the foreman, the stableboys, the day laborers, and the milk boys have been paid, the farm still shows a profit. In short, Katana is doing well. He has long since paid off his first loan for the cows and has gone on to expand his herd without having to use outside capital.

There has been plenty of work in the region since the dairy farmers really got going just a few years ago. In 1989 there were around 16,000 head of cattle, primarily local stock, in the vast Kilifi region that occupies the central section of the Kenyan coastline. Today they number at least 35,000, a large proportion of which are crossbreeds. Milk production is difficult to gauge, since so much of the milk is sold door to door. But these days, there is certainly less milk being transported from the rest of the country to the coast than before.

Going it alone

Kenya's Ministry of Agriculture and their collaborators in the internationally funded research program have every reason to feel pleased with the fine outcome of the development task they set for themselves in the late 1980s. The farmers were involved from the outset and today about 1,000 are involved, in an organized way, in the development of dairy farming. But many more have learned from the project, as the farmers offer friends, neighbors, and acquaintances good advice and plant cuttings. Groups of farmers pay regular visits to the KARI research station at Mtwapa, north of Mombasa, where new combinations of grass and trees are continually studied in an effort to get as much as possible out of the sandy soil.

The researchers believe that they have achieved a good balance between what the natural terrain can bear and what the farmers can produce. The local research station at Mtwapa now has things so well in hand that, in 1995, ILRI was able to pull out of the project and leave all the work in the hands of the Kenyan collaborators. But people from ILRI still pay occasional visits. As one researcher says, it is always good to come to Mtwapa if one is feeling less than optimistic about one of the other complex tasks facing international research.

Without poison, but naturally

Uganda

This is how a cassava plant ought to look when it is growing well and is not afflicted by disease or insect attacks And this is how a satisfied Ugandan farmer looks in his Sunday best

Kasibante Levi Makumbi, who has a farm in Namulonge, 30 kilometers from Kampala, the capital of Uganda, is exceptionally pleased with his field of cassava, which will soon be ripe for harvesting. To anyone else, however, tramping up and down between the rows can seem a bit monotonous. The bushy plants, nearly 2 meters tall, are all perfectly uniform; almost every leaf is fresh and green, and there is no trace of insect life. And best of all, the cassava tubers – the most useful part of the plant – are still hidden in the earth.

In short, as far as 24-year-old Kasibante is concerned, things could not be better. The plants are healthy and the cassava is stored away in the soil, where it can stay almost as long as is necessary. This last is nature's doing. Cassava grows well even in extremely poor soil and with limited amounts of rain. All varieties of cassava contain a certain amount of cyanide – a virulent poison in large concentrations, but, in its diluted form in the cassava tubers, just perfect for keeping pests in the soil at bay.

After a year or so, once the plant is fully grown, the root crop will remain strong and healthy for as much as three years with almost no further growth This means that it can be held in reserve for those times when other crops fail or run out. In Africa it is said that drought never yet led to famine in areas where the farmers grow cassava,

which is why a shrewd farmer will always have part of his land given over to cassava.

As it happens, Kasibante is not so concerned about the cassava tubers. What he is interested in are the stalks. But we will come back to that later.

Everyday fare

Cassava is grown along a broad belt across Africa and is a vital crop in countries like Ghana, Nigeria, and Benin in West Africa; and Uganda, Kenya, Tanzania, and Zambia in East Africa. It is not especially nutritious. What calories it does provide are relatively empty, but they are, nonetheless, calories – something that is always in demand in large areas of Africa. Cassava also happens to be rather difficult to prepare, precisely because of the cyanide. The tubers have to be raked through and rinsed, by machine or by hand, to get rid of the poison. But thereafter the cassava root can be ground down for meal or flour.

There are many places where cassava is more or less everyday fare, much as potatoes were in parts of Europe and North America 40 or 50 years ago; and, like the potato, the cassava root was imported from South America several hundred years back – a product of the trans-Atlantic slave trade.

Imported insects

In the 1960s, however, an old acquaintance – the cassava mealy bug – made its presence felt in the West African countryside. It had been introduced – as the biologists put it – by accident, from South America. It ate and ate, spreading rapidly eastward, and the situation looked totally disastrous for the cassava. The researchers were at their wits' end. Cassava may be a major crop in South America, but oddly enough the cassava mealy bug has posed no problem there, and so little research has gone into it.

As if this were not enough, in 1971 another nasty pest, the cassava green spider mite, also from South America, showed up. It was first discovered in Uganda, where it seemed to feel very much at home, and spread from there.

Both of these insects can ruin anywhere from 30 to 50 percent of a harvest. But one needs to know that it is, in fact, insects that are doing the damage, because it takes an extraordinarily powerful microscope and a trained eye to spot them.

A natural reaction

It took many years and a lot of experiments to reach a solution to the problem. There had to be a good explanation for why the cassava mealy bug, which the researchers turned their attention to first, was not a problem in South America.

Two international research centers, CIAT (Centro Internacional de Agricultura Tropical) in Colombia and IITA (International Institute of Tropical Agriculture) in Nigeria, instituted a search for the mealy bug in Brazil, a country that grows a lot of cassava. After much research, they discovered that the bug was held in check by parasitic wasps, although none of those species that were tested in the net cages of the laboratories really rose to the bait.

Fresh expeditions to diverse corners of South America eventually unearthed several promising parasitic wasps. The trick was to find out which of these was the most effective. Numerous requirements had to be met: it could not be harmful to useful insects or carry any disease into Africa; it had to be able to survive conditions in the African cassava belt, which can vary greatly over such a wide area; and it had to have an insatiable appetite and still be able to survive when mealy bugs were not so plentiful.

One small wasp appeared to be a likely candidate. It was transferred from South America to a laboratory in London where it could be certified as disease-free and be hatched by the thousands. Tests in the fields of West Africa exceeded expectations, and the wasp cut a swath along the trail left by the mealy bug. It was usually deposited in small batches in the stricken areas, but occasionally dropped from airplanes.

Easier and easier

A team of highly specialized researchers had been assigned to the project and the most modern methods and instruments employed in order to obtain the desired objective. After that it was a case of developing a technique that could be replicated even in the most modest laboratories in Africa. And it was the IITA scientists who came up with the simple and ingenious solutions to producing the wasps locally, by the millions

The Ugandan researchers at the research station in Namulonge happily demonstrate how they are now running the system themselves. The entire production set-up consists of no more than a sleeve of thin plastic, 1.5 meters in length, filled with sawdust and suspended from a cord. Above this hangs a small bucket with a hose for watering the sawdust. Lots of little holes have been cut in the plastic bag. Short lengths of cassava stalk are stuck into the holes and before long these put out roots and leaves, giving the impression of a little Christmas tree of cassava cuttings. The cassava plant really can get by with very little nourishment.

The tree is transferred into a tent made of very fine mosquito netting, into which the destructive mealy bugs are then released. They come from little net cages in which they have gorged themselves on cassava leaves. Their delight in all this fresh guzzling potential is short-lived, however, as cassava branches crawling with parasitic wasps are inserted into the tent. Now it is the wasps' turn to feed, and this they do in record time.

This process can quietly go on until the wasps are needed somewhere else. When that happens, the lower part of the tent is covered with a length of black fabric and the wasps crawl up toward the light at the top and into a little canister of clear plastic.

Within 12 hours, most of the wasps are inside the plastic canister, which is then packed into a cool box (complete with cooling elements), to keep the wasps subdued. Thereafter, it is a matter of getting out to the field before the temperature rises. The wasps are released onto the stricken field and soon have things under control.

The researchers breed parasitic wasps in mosquito-netting tents as required to keep the destructive mealy bug in check.

The very first such operation took place in Uganda, when the mealy bug turned up there in 1992. In those days the Ugandans were not equipped to tackle the problem themselves, but within 12 hours of the discovery, IITA had flown in a consignment of parasitic wasps. After that it was only a three-hour drive in the little cool box before the battle for "biological control" commenced.

Green is not always good

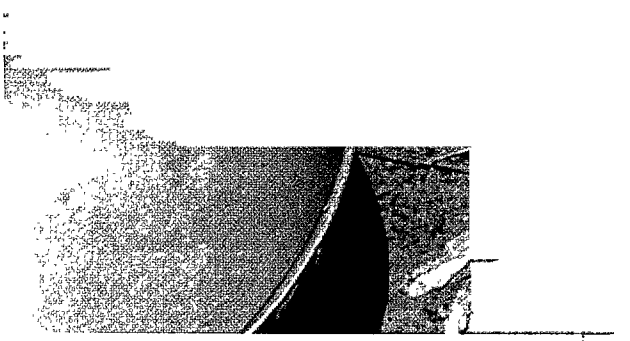
Having learned from their experiences with the mealy bug, the researchers could – in theory, at any rate – calculate that the other pest, the cassava green spider mite, would also be susceptible to biological control. Attempts had been made to spray it with insecticide, but for many good reasons – primarily financial ones – these never really came to anything.

The international research centers therefore dispatched new expeditions to various parts of South America, and five different predator mites captured in Colombia were tried out against the cassava green spider mite. Between 1984 and 1988, 5.2 million predator mites were deployed at 341 locations in 11 African countries. None survived, presumably because they could find no other food once they had eaten the cassava mites.

It was an expensive lesson, and the next attempt focused specifically on locating predator mites from regions with climates more closely resembling those in Africa. There was a lot riding on the second deployment, too. Five different predator mites were dropped off at 365 points, again in 11 countries, between 1989 and 1995. Three of these did fairly well.

The big surprise proved to be a predator mite not included in the experiment until 1993. It can now be found in over 1,000 districts in both East and West Africa: a lively character, capable, in its first season, of ranging 12 kilometers from the drop-off point and, in the second year, of traveling up to 200 kilometers. It now covers over 400,000 square kilometers. This predator mite, which has both a first and a last name – Typhlodromalus aripo – also lives on pollen, the nectar from flowers, and the sap of plants, so even when the number of cassava mites is falling off, it manages to survive. It can produce two generations for every one of the green mite's, so it is not much of a contest.

In fact this predator mite has more than paid its way. Researchers have calculated that when the predator mite is let loose in a field attacked by the cassava green spider mite, production rises by between 30 and 40 percent. In West Africa alone this has resulted in a gain of US$48.5 million per year.



The monotony of the cassava field

Thanks to the parasitic wasp and the predator mite, everything is bursting with health on Kasibante's farm at Namulonge. The cassava green spider mite never made it to this district in the center of the country, because the predator mite rapidly put paid to invasions from both Kenya and,

The ripe cassava resembles a huge potato, but needs a great deal more preparation before it reaches the dinner table.

later, Zaire. And the mealy bug does not stand a chance in Kasibante's field. At the first sign of an attack, he simply takes a top shoot from a cassava plant containing parasitic wasps and places it on one of his cassava bushes, and order is soon restored.

But Kasibante's field is an especially good one, because last year he was allowed to try out a new variety of cassava from the research station near the highway. It is one of the varieties from which IITA is expecting great things, standing up well, as it does, to plant diseases while producing nearly twice as much as the type that Kasibante grew last year and that most local farmers are still using.

The deadliest disease is caused by a virus known as leaf mosaic. It is spread by another insect, the whitefly, also a microscopic bug. The leaves turn yellow and the plant ceases to grow. Even so, for the first year it can stagger along, albeit with a drop in yield of up to 50 or 60 percent.

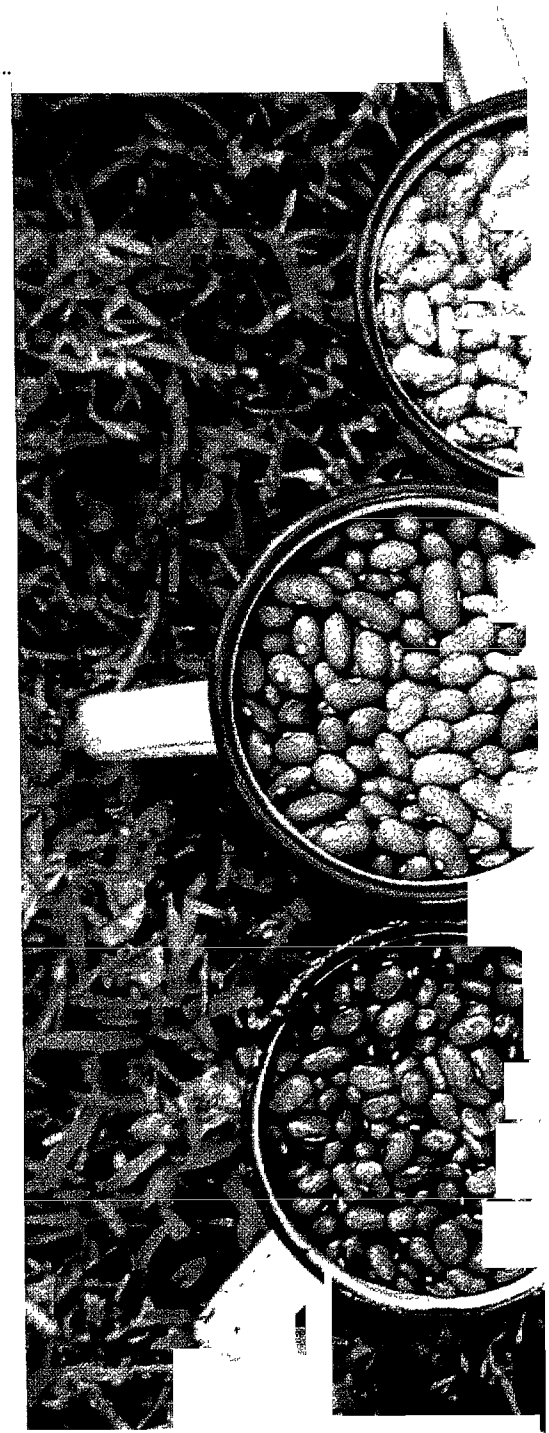
But it is during the next year, when the farmer plants cuttings from his sick plants, that the trouble really starts. Because the plants are diseased to start with, total devastation of the cassava crop is inevitable. The only hope for the farmers lies therefore in plants that are resistant to the virus or that are likely to be only mildly affected. In fact, the cassava has suffered severe setbacks in Uganda and has disappeared completely from certain areas.

All of the neighboring farmers have been up to take a look at Kasibante's field and a couple of trial uprootings have been made, even though the tubers are not quite ready yet. Kasibante's plants are obviously healthy. Everyone is convinced that they, too, should plant the new cassava variety next season.

And that is why Kasibante pays most attention to the stalks: cassava is propagated by sticking a cutting from the stalk in the soil when it is suitably moist. He has promised to give lots of cuttings to his neighbors, but there will still be plenty to sell afterwards. A truckload, as he knows, pays around $300, and he expects to be able to fill a couple of those.

The IITA researchers and their Ugandan colleagues are justifiably proud of a "job well done." And they are now busily engaged in tracking down another gluttonous insect that can stalk the whitefly. After all, it is always wise to have more than one countermeasure up one's sleeve when dealing with such vicious foes as viruses and pestilential insects.

NOURISHMENT AND UNDERNOURISHMENT

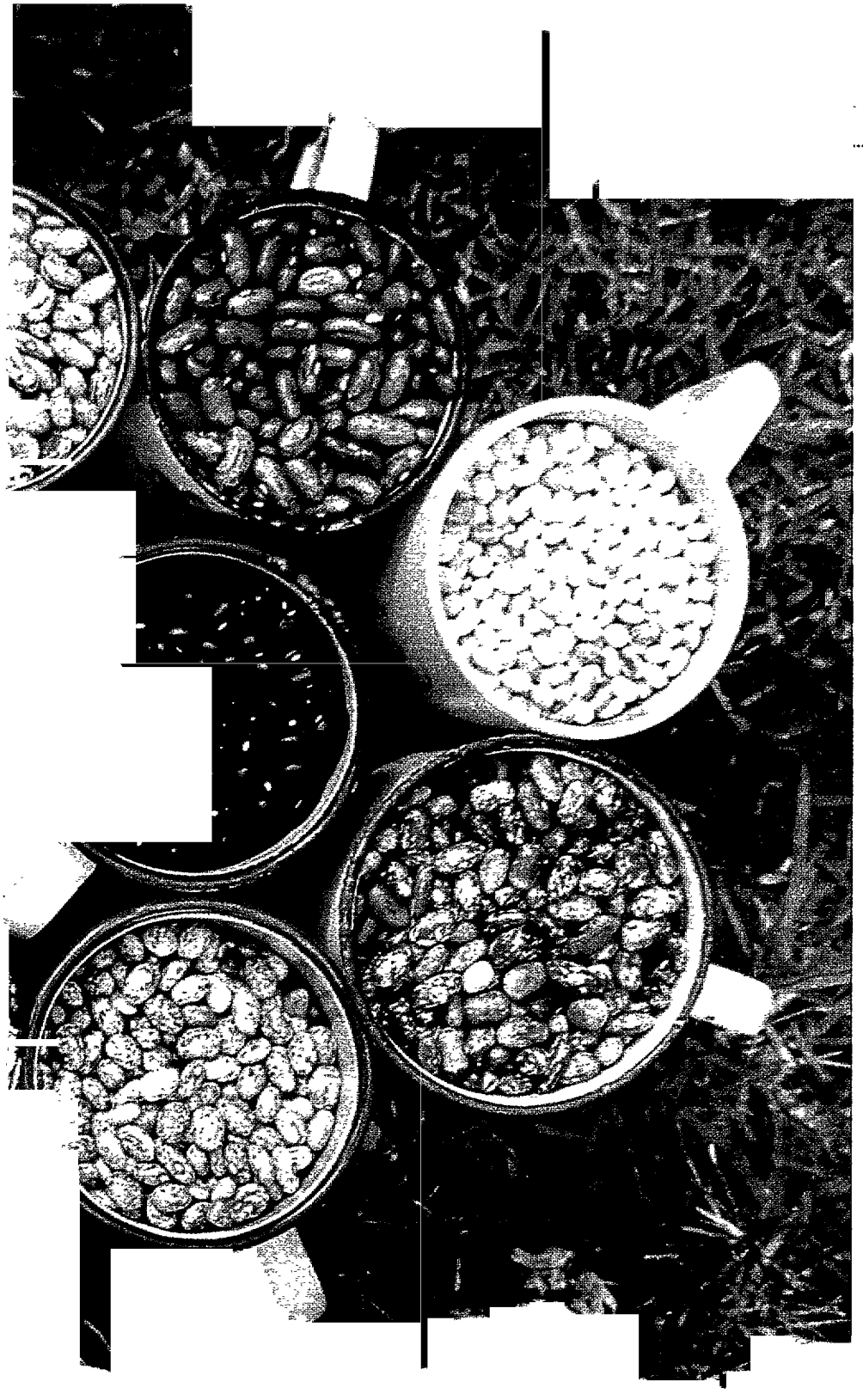


The last few decades have seen a worldwide improvement in nutritional standards. The one region that has experienced negative growth is Africa, south of the Sahara. Here, according to statistics issued by the United Nations Children's Fund (UNICEF), an estimated 30 percent of all children under the age of five are underweight and 41 percent are not as tall as they ought to be for their age.

It is the youngest children who are most susceptible to undernourishment. They have a great need for energy and nutrients, not least of all because they have to grow. A one-year-old child must consume at least 10 percent of its own body weight every day in order for its needs to be met. If it does not get enough, this will have an effect on its immediate growth and development. And in cases of prolonged deficiency, it can also have a bearing on intellectual development, the risk of contracting infectious diseases, and growth later in life. Nourishment for the unborn child and the breastfed baby is also important. Even though the mother's body puts the child first both during pregnancy and while breast-feeding, pronounced undernourishment in the mother during these critical periods cannot help but affect the child. In adults, undernourishment leads to a reduced working capacity, partly because they contract so many infectious diseases.

The immediate causes of undernourishment are a deficiency of energy and nutrients and the recurrence of infectious diseases. Energy deficiency – that is, not enough food – is a primary concern. Most grains contain an adequate amount of protein, provided that enough is eaten to cover the individual's energy requirement. The last decade has brought with it a growing awareness about the crucial part played by micronutrients for growth. The type of undernourishment induced by a deficiency of vitamins and minerals is known as "hidden undernourishment," because it can be difficult to detect if not accompanied by an energy deficiency.

One important example is presented by vitamin A deficiency. The most marked deficiency, one that produces sores on the cornea and causes blindness, is rare. On the other hand, a more moderate deficiency is very common, but can only be diagnosed through blood tests. And the more moderate deficiency leads to a significant increase in vulnerability to infection. In countries where vitamin A deficiency is prevalent, it has been shown that more than 20 percent of all deaths among children under the age of five could be prevented by dispensing adequate amounts of vitamin A, which is found in fruit and vegetables, among other things. Another prime example of hidden undernourishment is iron deficiency. In quite a few countries, almost half of all women and children suffer from this deficiency, which can result in retarded de-



velopment, reduced working capacity, and greater susceptibility to infectious disease.

A high nutritional standard depends on both quantity (energy) and quality (protein and micronutrients). Agriculture is absolutely crucial in the battle against undernourishment and the emphasis has to be on both quantity and quality. It is important that production of staple foods such as maize, millet, cassava, and durra is increased in order to supply more energy. Although the micronutrient content of these staple foods is generally not great, such large amounts are eaten that even minor differences in micronutrient quality acquire major significance. For this reason international agricultural research has begun to take an interest in the differences in nutritional content in these foodstuffs, with the aim of propagating new varieties that have a high micronutrient content. In addition, it is important that the staple diet be supplemented with vegetables, fruit, and, where possible, small amounts of animal produce such as milk, fish, and meat, all of which boast a high concentration of numerous micronutrients. A varied diet is vital, and improved agriculture should ensure that every family is able either to produce these foodstuffs themselves or to buy them at a price they can afford in the local market.

Oddly enough, in many developing countries one finds what amounts to a virtual epidemic of so-called lifestyle ailments – obesity, cardiovascular disease, diabetes, and the like – among the more affluent members of society. It is assumed that one of the contributory causes is undernourishment early in life, thereby increasing the risk of contracting such illnesses in adulthood.

Down-to-earth research

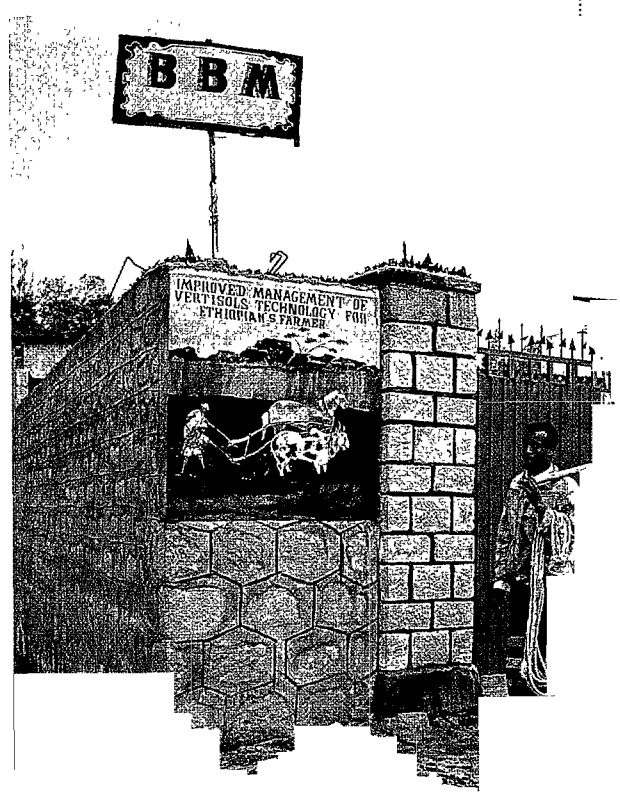
Ethiopia

The first advertising sign heaves into sight alongside the busy highway in a suburb of Addis Ababa, capital of Ethiopia: a metal board adorned with a local artist's idyllic representation of a team of oxen and the legend, BBM 200 meters. Far down a bumpy gravel track the next sign – sporting a similar scene and an arrow – appears. No promise here, though, that one is almost there. After a long drive between forbidding corrugated-iron walls the road comes to an end in front of the last sign; this one is larger and grander, hanging on a stone wall. Behind this wall, production and profit combine with agricultural research in excellent fashion, not that there is any plowing going on in there. Tucked away behind the wall is a little workshop producing curved iron plates and heavy iron chains. And business is booming.

Age-old technique – new problems

This story begins more than 3,000 years ago with the first plows ever used in Ethiopia. A very long pointed branch, two wooden planks set at an angle, and a yoke to lay across the backs of a team of oxen. Centuries ago the addition of a metal cone fitted over the branch tip improved this plow, but other than that the design has remained unaltered.

It does the job very well, as far as it goes, but it is a slow business. Prior to sowing, the fields have to be plowed again and again before all the soil is turned and leveled. It suits the local conditions, but only where the soil is light.



Approximately 10 percent of what could be the best farmland in central Ethiopia consists of black clay soils that alternate between being dense, clogged, and nearly swamped during the rainy season, and hard and cracked during the dry spells. Neither plow nor plant-life copes well with such conditions. And we are talking here of more than 10 million acres of land.

With a population that is growing rapidly, the need for greater agricultural yield is strong and every bit of land has to be used, even the most intractable stretches of soggy black clay. In the majority of places the black soil is prepared when the spring rains begin in March and then lies bare and empty, drying out once more before the long rainy season begins in June. It is also left to rest in September and only then can the corn be sown. Plants do grow in the waterlogged soil, but not as well as they might: the soil is so dense that the roots find it hard to function. And on the fringes of each field the shoots grow weak and yellow, because that is where water gathers, almost smothering the plants.

The arduous solution ...

Although something can be done about this problem, it means working by hand, toiling long and hard during the damp and chilly months of the year. Women and children hoe the soil up into narrow rows, in such a way that the top of each row becomes drier and better for the corn. But the rows are fragile and a heavy downpour can easily wash them away. Another technique involves digging ditches across the field at 10- to 12-meter intervals, but these do not drain off enough water.

In a very few parts of the country another, considerably better, solution has been implemented: constructing plots a little over a meter wide, interspersed with ditches. This does help, but it is a hard slog, working the stodgy soil by hand, often in torrential rain. And it is here that the agricultural researchers come in.

... and the efficacious answer

In 1986 tests were initiated by ILRI researchers in various parts of the country in an effort to ascertain the ideal dimensions for these beds. Eighty centimeter-wide raised beds, combined with ditches 20 centimeters (8 inches) wide by 20 centimeters deep proved to be exactly what was required.

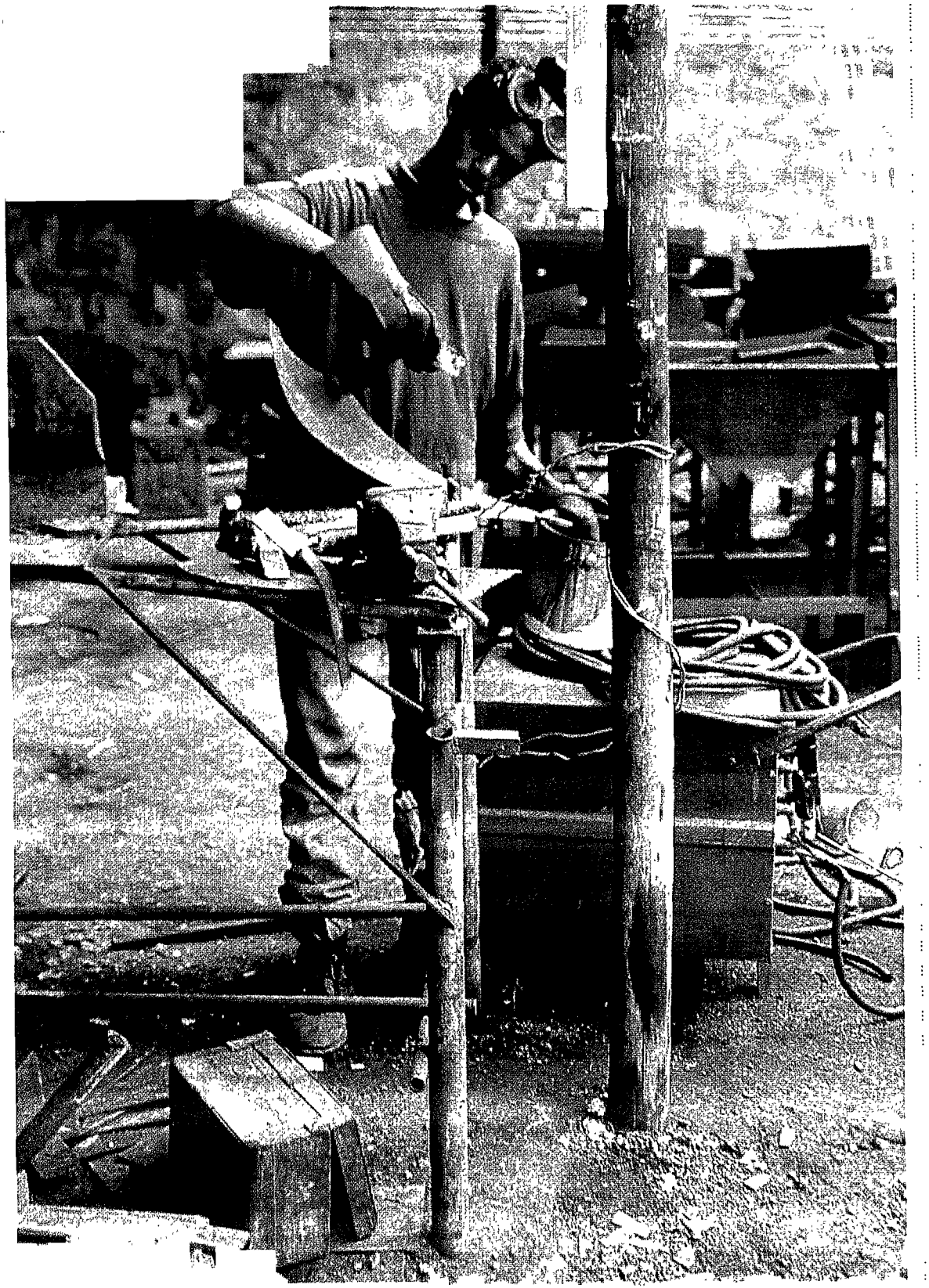
To get around the heavy physical work of building up the beds, researchers began to construct a number of different implements. Although this was not a particularly difficult assignment, the researchers were not easily satisfied: either the equipment was too heavy, or there were too many parts that would have had to be purchased abroad or that were hard to come by. And all of the tentative solutions were beyond the means of the ordinary farmer. So the traditional plow came to form the basis for the further development of what would eventually become the BBM referred to on the sign in that Addis Ababa suburb: the Broad Bed Maker.

The tips of two plows are bound together up at the front, between the shoulders of the oxen. At the other end they are connected by a branch tied between them, thus forming an elongated triangle. A curved steel plate is fixed to the outer edge of each plowshare, the distance between these being exactly 80 centimeters. At the very back a steel chain is drawn across the soil between the two

The double plow makes the rounds of the research station field in fine, dry weather. But it is in the pouring rain of an autumn day that it has to prove itself, and it does

The sign makes for a good, if slightly overstated, piece of advertising. Behind the gate, parts are made for the BBM double plow, which has done away with the need for a lot of hard hoeing.

The workshop may not be all that fancy, but with only a few pieces of machinery and good craftsmen, it has produced thousands of plowshares over the last few years



plows, leveling it as it goes. The whole set-up costs the equivalent of about US$35, the very most that a typical Ethiopian farmer could ever dream of investing.

The BBM is pulled across the freshly plowed field and the long beds are ready. The seed-corn is hand sown and the BBM runs across the beds once again, this time in order to cover the seed with just a few centimeters of soil.

This method has many advantages. The land can even be used during the short rainy season that starts in February, making it possible to gather in two harvests. And by doing this, the fields are not left open to leaching and soil erosion for half the year.

Package deal for the farmers

Agricultural researchers from ILRI supplemented the new method with a modicum of good advice and support. They also offered new seed varieties capable of giving higher yields than the traditional strains, and well suited to a long and rainy growing season. Small quantities of fertilizer were also included in the standard package presented to the farmers, together with a recommendation for more intensive weeding of the fields. But perhaps most important of all was the offer of a loan to cover the lion's share of the cash required for the BBM and the fertilizer: a loan to be paid back once the harvest was in.

The results were apparent from the very first harvest. The new technique and the new varieties were superior in every way, and they produced a corn crop that, at its best, was three times greater than before. During the spring season many farmers were able to grow leguminous plants, which are good for enriching the soil and introducing some variation into the diet.

The successful results are largely due to the fact that the seed-corn is now covered by a layer of earth of exactly the right depth. With the standard plows, some seeds send up shoots without putting down roots, while other seeds get buried as far down as the plow can delve. Which means that far too much seed-corn is expended on the sowing of one field.

Selling like hot cakes

It is hardly surprising that the BBM has been much in demand. Since 1995, when the perfected model became available, at least 25,000 BBMs have been sold, and many of these have been produced by the little workshop up that side road in Addis Ababa. The workshop boss, Ferdawek Debele, worked for ILRI for 10 years before seeing his chance to strike out on his own and combine a healthy business with a worthwhile development project.

But it has to be said that Ferdawek is no ordinary businessman. He is often out and about in other parts of the country, instructing other workshops on the production of the new plow. And he gives a lot of time to advising farmers on the BBM package. Preparation of the soil on its own is not enough, since the traditional seed varieties will die off should they be exposed to a lengthy bout of rain. Ferdawek himself points out that the good harvests are a major benefit. But he is also overjoyed to know that women and children no longer have to work their fingers to the bone in the fields. The new technique takes only one-third the time it formerly took to do the job by hand.

More on the drawing board

ILRI is currently experimenting with other tools adapted for the triangular frame: for example, the pole set crosswise between the two plows can be converted for use as a sower, or a weeder can be attached, as can hooks designed to turn over only the topmost layer of soil. In this way, the beds can be maintained without the hard slog of plowing up the entire field before each season. The agricultural researchers and engineers are still working on making such implements simpler, cheaper, and easier to use, but the outlook is bright.

The market is far from saturated. ILRI's splendid achievement continues to go from strength to strength as the technique spreads of its own accord and is adopted in other parts of Africa.

Drain the water off the heavy black soil and it yields excellent results.

More than a hill of beans

Kenya

The new beans have been welcomed with open arms by local women's groups for their good, steady yield and the variety they bring to the daily diet

In the early 1990s, farmers in the villages of the Kakamega District in western Kenya received a nasty shock. Almost from one day to the next their bean plants either withered and died or grew stunted and puny. It became all but impossible to grow beans in that part of the country.

This was a serious matter, since beans constitute a vital part of their daily diet, second only to maize. And even though maize provides more calories, the essential proteins in the diet come primarily from beans, which also provide an excellent supply of iron.

In 1994 the Kakamega District, with a population of around 4 million, was producing roughly 50,000 tons of beans, but this figure was dropping steadily and many small farmers had given up farming them. Most of the farmers own only a few acres of farmland, so every inch has to be cultivated. The rains make it possible to harvest two crops each year, and this has long been the practice. What happens is that nourishment is systematically drawn out of the soil, and ordinary smallholders – about 90 percent of all those working the land in the Kakamega – cannot afford to redress the balance by adding fertilizer. One result of this depletion of the soil was the lamentable bean crop.

Being poor costs dear

It was precisely this nutritional imbalance in the soil that ruined the bean crop. The soil was eventually so exhausted that several of the bean's worst enemies were suddenly able to gain the upper hand.

Felista Manyengo, who lives with her five children and her mother-in-law in the village of Shinyalu, farms the family's land herself, while her husband draws a regular wage from his job in the capital of Kisumu in Western Kenya. Among other things, his wages go toward paying the school fees for four of their children.

Felista was as surprised as her neighbors when, all at once in 1993, they found that the beans were no longer flourishing.

A complex answer

Fortunately, the bean researchers at CIAT, the international agricultural research center in Colombia, were not caught unawares. They had seen the same story before in Rwanda in the late 1980s and in Uganda a year or two later: suddenly the exploitation of the soil went beyond the limit; the beans were sapped of strength and their foes moved in. The researchers had some good advice to pass on to

Felista Manyengo and she is now back to growing beans.

First, the researchers knew something of which the farmers were not aware: one of their problems was a fungal growth that caused the roots to rot. The other was an insect whose larvae burrowed into the stalks and interfered with the absorption of nutrients from the soil. They make a daunting combination, causing an ailing stock, a yellowing of the leaves, and a stunting of the plant.

The researchers also knew what to do to remedy matters. Their recipe, containing many ingredients, was based on experience gleaned from other countries in the region that had suffered problems with their beans.

Before anything else, it was essential to build up the energy levels in the topsoil, and purchasing fertilizer was out of the question. This meant getting hold of all the green manure to be had from agricultural waste, supplemented by whatever weeds, leaves, and twigs could be gleaned from roadsides, hedgerows, and garden plots next to the houses. The community's handful of cows supplied a small amount of manure, to be used on the beans rather than the maize, although in most parts it is hard to differentiate, since it is common practice to grow the beans among the maize.

Preventing the soil around the roots of the bean plants from becoming too damp is another remedy. The annual rainfall around Kakamega can be as much as 2,000 millimeters (79 inches), approximately three times as much as in a European country like Denmark, and during the two rainy seasons the fields are often dotted with puddles and small ponds for a large part of the day after a shower. Because fungi and insect larvae love dampness, it made sense to grow the beans in elevated beds, raised 15–20 centimeters (6–8 inches) above drainage ditches, or on small embankments.

It is also worth shoveling the soil up around the plants, to encourage the formation of roots high up, where the moisture levels in the earth are at their lowest. It also helps to place the germinated beans just beneath the surface rather than planting them down at the bottom of a hole. Another useful tip followed by farmers with more ground is to rotate the crops from one piece of land to another, season by season, otherwise the fungus problem in particular becomes more and more severe.

Felista has taken all of this good advice, as can clearly be seen from her field, in which the beans grow in long, straight and beautifully green rows.

But there is plenty more that can be done.

Mrs. Manyengo has land enough for growing the trailing bush beans. They are in great demand in the local market.

A satisfied smallholder

John Imbenzi, from the neighboring village of Ivakale, is a smallholder whose circumstances could be described as straitened, in the most literal sense of that word. His holding amounts to just 1 acre, and yet on it he has maize, cabbage, spinach, a mango tree, a couple of banana plants, a few flowers climbing up the side of the house, and, of course, beans. John keeps a rabbit or two, some chickens, a goat and one cow in a stable-cum-pen, and he has also found room for a well-tended compost heap created out of cow dung and vegetable waste.

Most surprising is a tiny grove of slender trees about three to four meters tall and a couple of sunflower plants, which have a terrible time of it with the birds. But how does he manage all this on his shamba, as a smallholding is called in Kiswahili? With his little daughter held by the hand and the family dog at his heels, John shows off his property and explains how it all came about.

He had given up growing beans on his plot when his plants grew as sickly as those of other small farmers in the village. But the bean researchers at the agricultural center in Kakamega, having run trials on a number of the local beans as well as the newly developed strains from CIAT, suggested that he try a completely new variety, which had done exceptionally well in Rwanda. This was a climbing bean rather than the trailing variety, the bush bean, which had been grown up until then.

Early in 1996 he received a quarter of a kilo of germinating beans from the research station, a gift worth about 90 cents, no small amount in those parts. The only stipulation made by the researchers was that they would monitor the outcome of the experiment.

For climbing beans John needed beanpoles for the plants to twine their way up. And it was this that prompted him to plant his little grove of trees on a patch of ground measuring about 25 square meters. The trees sprang up from seed in only eight months. These are sesbania trees, good for many things besides beanpoles. Their leaves make good eating for the cow, and the dead wood and fallen branches go straight into the clay oven to feed the cooking fire. Not only that, but they fertilize the ground in which they grow, as their roots transmit nitrogen to the soil from the air.

It is amazing what the little smallholder family manages to produce from a plot of land not much bigger than a suburban garden in a modern town. The beans represent a vital part of the harvest.

Climbing beans are the obvious answer to a hard-pressed smallholder's space problem. They grow upward, climbing many meters into the air if the poles are tall enough; if not, they turn around at the top and start creeping downward again. They require no more room on the ground than bush beans. The researchers have come up with varieties of both climbing and bush beans that are almost totally resistant to fungal growths and pests.

The lanky bean plants start to produce pods almost at the same time as the bush beans. And it does not take long for the 20 to 25 pods, considered a good crop for a bush bean, to appear. But the climbing bean goes on producing over its long growing period, and there are never less than 80 pods on the plants John points out. Nor does it look as if he will have to worry about the birds going for them. Actually the birds are very fond of the half-ripened beans, but they like sunflower seeds even better. Sunflowers are sown so that the birds can stuff themselves

with sunflower seeds to their hearts' content, leaving the beans alone.

Teamwork

Senende is another of the 12 villages in the district with which the researchers have been working since 1996 to promote bean-growing. Here they work hand in hand with a women's group set up by its members in 1993 to help one another in the event of sickness or other problems. These women have also opted for climbing beans, which they are now growing for the second season in succession. They did not hear of the ploy with the sunflowers until recently, so theirs have been sown too late this time. But they are not very worried; after all, the birds cannot polish off that many beans.

The new beans suit them just fine, taste good, and have a lovely yellow color that appeals to everyone: one might think that eggs had been mixed in with the dish of beans. Oh yes, there are other new varieties, in almost all the colors of the rainbow, but prices tend to vary, because the most popular beans – even the pale purple one – sell better at market.

And, as housewives, they cite two other advantages. The new beans are softer than the traditional varieties and only have to be cooked for an hour, as opposed to two hours for the old kinds. This leads to big savings on fuel, which is thin on the ground in an area where there is no room to spare for growing all the trees they need.

The Senende group has taught the researchers a few tricks that they can pass on to other farmers. Indeed, often it is not the researchers themselves, but an energetic private organization that spreads the good word and makes sure that new experience is relayed to all interested parties.

The future

Thanks to this communication, there are lots of other people besides the 12 village groups who know what has been going on, and many of them will buy the new varieties of bean for their plots of land after the harvest in July. These are doled out sparingly, often as little as a few hundred grams at a time, since the researchers would prefer to see the farmers trying out several different types in order to find the ones best suited to their particular piece of land. This was how bean production was revived in Rwanda and Uganda, when these countries experienced similar problems just a few years ago.

Problems do, of course, arise, especially when it comes to ensuring that the soil receives enough in the way of nutrients: competition for the green manure is fierce, as it is for other crops. But one can only hope that with more money coming in, there will be enough to spare for at least a few bags of fertilizer for the soil, since in this situation even a sprinkling makes all the difference. And with the plants hungry for nourishment there is no risk of any of it seeping down into the subsoil and being wasted.

Although it may seem a trifling matter, difficulties can arise in obtaining enough beanpoles. And, of course, there is always the chance that farmers will grow more lax once disease and insects no longer seem to present such a threat.

Not that that is liable to happen straightaway, when everyone can recall only too well how bleak things were looking only two or three seasons ago, before international research showed the farmers that their efforts could, indeed, amount to much more than a hill of beans.

A winning way with weeds

Kenya

The highways around the small town of Maseno in the westernmost corner of Kenya are lined by the loveliest green bushes, thick with yellow, star-shaped flowers. These are called wild sunflowers and they add a bright splash of color to all the surrounding greenery.

It is hard to believe that such a decorative weed could also be useful. The researchers had no idea, either, when they began to experiment with using the wild sunflower for agricultural purposes.

As they put it: "We have a phosphorus problem." Or to be more precise, the soil in Western Kenya has been divided up into so many little plots that almost every inch of land is being cultivated for the better part of each year. But the farmers cannot afford to use fertilizer and the soil is, therefore, being systematically exhausted. So much so that the researchers talk of soil mining.

The soil contains three ingredients vital to the growth of plants: nitrogen, phosphorus, and potash. It has been calculated that a maize field covering 1 hectare of land will lose 36 kilos of nitrogen, 2.5 kilos of phosphorus, and 25 kilos of potash a year, when the soil is exploited as it is in this region.

The majority of fields display clear evidence of this exhaustion, with the maize – even at the end of the long rainy season – spindly and standing a little over a meter tall. Had there been the space and the money to keep cows, spreading a bit of manure would go a long way toward rectifying matters. But there are not that many cows in this region.

How to fertilize without fertilizer

Things being as they are, ICRAF, the International Centre for Research in Agroforestry, has joined forces with local researchers in a bid to persuade farmers to use the waste from the harvest as "green manure." Straw, beanstalks, cabbage stalks, fallen leaves, and other waste are dug back into the soil to replenish the nutrient content.

But the soil is still living on short rations, as is the average local household. An average-sized family will number as many as seven people, including adults, adolescents, and young children. Each person requires approximately 120 kilos of maize per year, but even in a good year, with plenty of rain, a typical smallholder's family will have to do without maize for three months of the year and endeavor to make ends meet by doing odd jobs in addition to working their land.

Happily, however, they have the pretty weed with the charming name: wild sunflower, or *Tithonia diversifolia*, as the researchers and even many of the farmers call it. It was included in a more extensive experiment.

Some plants have the capacity to absorb nitrogen from the air and store it in the stem and leaves and in little nodules on the roots. If left in the soil, the roots will supply the nitrogen for other plants next season. Beans and peas have this knack of storing nitrogen, and there are also quite a few pulse-bearing trees and bushes, which, as the researchers say, "fix" nitrogen.

A mixture of green manure and leguminous plants is already a step in the right direction. And to make the application of green manure easier, the Kenyan researchers and their international colleagues collected samples of plants that grew close to the farmers' fields, to see whether any of these were particularly well-suited for digging into the soil. A lot of manure has to be spread if it is to do any real good: about 4-5 tons per acre.

The farmers had noticed that there was always a good crop of maize when a patch of ground was cleared of wild sunflowers and maize seeds sown in their place. So the sunflower was taken back to the test fields and the laboratory. And then people really did start to take note, for the leaves and flowers of the wild sunflower were found to be packed with soil nourishment. The leafy plant had the ability to check nitrogen starvation, and it provided plenty of potash. It also contained a fair bit of phosphorus, but not enough: "We have a phosphorus problem."

The cheerful yellow flowers lining the roadside are no longer just for decoration – as green manure they are much in demand

Visible effect

This fact did not, however, discourage Suslia Abong, a widow from the village of Luero near Maseno. She had seen how things improved when the researchers visited the village in 1995 to work with the farmers. Now something good happened to Suslia.

In other respects, she has had a hard life. She estimates that she was born around 1927 and fondly recalls her honeymoon in the Kenyan capital in 1939, just at the time when the Second World War broke out. So she must now be a little over 70 years of age, but still farming actively – well, how else could she support herself and her orphaned 10-year-old grandson, who is kept at school, even though that costs money. Suslia knows how important this is: she herself never went to school.

Everyone in Suslia's village was offered the chance to try out the new method of manuring. Those who were quick off the mark were involved in the project from the start; Suslia held off for a season. The first test farmers cut branches from the wild sunflower bush, and when "the short rainy season" started in September, these were stuck in the soil in the fields or around the edges of smaller patches. The sunflower cuttings can hardly help taking root, while corn and other crops have a harder job holding their own in the short rainy season. Hence, the soil is normally left to rest.

Now, however, the time is used to grow green manure. At the beginning of 1996, with "the long rainy season" just around the corner, the sunflowers were dug into the

Old Mrs. Abong still works her own farm, which has been doing much better in the past few years thanks to the enriched soil and the improved maize

The short maize stalks in the foreground and the tall plants behind are of exactly the same variety, sown at the same time. The difference in growth is due solely to the green manure

ground and the maize planted as usual. Only a few months later it was hard to believe that the maize in the test farmers' fields was exactly the same kind as that growing in the fields right next door. The plants were up to three times as tall, the stems were thicker, and the development of the cobs was much further advanced.

For 30-year-old Charles Ngolo from the neighboring village of West Bunyore the future has been well under way since 1995, when he took part in the first phase of the project. He, too, comes from a large family and when the land was divided up on the death of his father there were only a few acres of land for each of the brothers. "But now the daughters also want their share," he sighs, so there may be less and less land available as time goes on.

So far, though, things are going uncommonly well for Charles. He is already working on another improvement: the cultivation of sesbania trees, which also fix nitrogen.

Farmers as researchers

Charles tried fertilizing maize with sunflowers for one season, with splendid results. But there is not much money to be made from maize, since the small farmers have to sell their crop right after the harvest, when the prices are at rock bottom. It is the handful of large-scale farmers and the grain merchants who rake in the big money.

Digging the weed cuttings into the soil is hard work, but the enterprising young farmers can reap the full reward

After the harvest, with the onset of the short rainy season, Charles and his neighbor tried out something different. Once again they prepared the field and dug wild sunflowers into the planting holes. They then added a sprinkling of the phosphorus that had been recommended and that the budget could now include after the good harvest. The holes were then planted with cabbages.

The researchers followed their progress with interest; nothing like this had ever been tried before. It turned out to be an excellent idea. Throughout both the short and the long rainy seasons, Charles was able to cut cabbage leaves from his plants, which kept producing new ones. At the market in Maseno, cabbage leaves sell like hot cakes and Charles guesses he earned 10,000 Kenya shillings from this venture. That works out to around US$180, a great deal of money – bearing in mind that a hired hand on a farm earns around 75 cents a day.

His neighbor talks of having made an even bigger profit, even though he, too, allotted only half an acre to the experiment. Not that it can really be called an experiment any longer, since the two neighbors are all set to continue and other farmers are itching to get started once the rains come.

Charles's neighbor is also working on a few other little projects: tomatoes fertilized by manure from his one cow and tomatoes fertilized by wild sunflowers – with phosphorus and without; and just a few tomato plants with withered grass spread round the soil at their feet because, who knows, there might be something in that. He has noticed that this is the method employed in the research station fields, where as many as a dozen different combinations are tried out in the maize patches. There seems no reason why the same cannot be done with tomatoes.

One woman, who runs her smallholding single-handed, regrets that she took so long to get involved in the project. She has spent the long rainy season planting sesbania trees and wild sunflowers among the maize, to ensure that there will be something to dig in once the maize has been harvested. Then she will try her luck with a second harvest during the short rainy season. The researchers are watching with interest.

Yet another shrewd farmer with a couple of cows, mind-

ful of all the sustenance in wild sunflowers, has fed them to his cows. While the cows are not all that crazy about them, if there is nothing else to be had, they wolf them down. Eating the flowers has not made them grow any bigger: unlike real sunflowers, the wild variety does not contain any oil. But the farmer has found that the manure from the cows is considerably richer than usual. This is one more experiment to be taken back to the laboratories and put under the microscopes.

Good results

Exactly how much better the maize grown in the research center test fields is – where water, the volume of fertilizer, the types of maize, weed control, and soil enrichment are all carefully monitored – is easily gauged. And it can be three times better than that produced by the farmers' old-style method. In an effort to get closer to actual conditions, the researchers have rented land from the farmers. This means that trials are now being carried out among the villagers' own fields and everyone can follow the progress from sowing to harvesting. The farmers do not keep figures for their fields in the same way as the research center, but they are more than happy to talk about a really good year.

Charles can now afford to enroll the oldest of his four children in the local school, and he is saving up for a new house. The corrugated iron for the roof has already been bought, and he and his wife have agreed on where on their land to build.

Old Suslia's plans are not nearly so ambitious. She is happy to be able to keep her grandchild at school and buy new school uniforms – no small expense at around 2,500 shillings a year. The profit she expects to make from the next harvest will be spent wisely: on fertilizer to redress the phosphorus balance.

And the other benefits

As we are walking along between the walls of tall maize plants, with a host of other women at our heels, Suslia describes the changes that have taken place. When asked how the life of the village has been affected by its involvement in the experiment, she is not the only one to reply. The women speak animatedly in their own language, *luo*, and the Kenyan agricultural advisor translates their collective answer: it has led to much more cooperation, everyone talks more to one another, and neighbors are more willing to lend a helping hand.

Another important factor, according to the advisor, is that the chances of a good harvest are now much greater. The liberally fertilized plants develop much faster. The seed is not sown until the rains come, even if they are late. And if the rains should let them down at the end of the rainy season, the largest plants will still give a good yield The smaller plants, growing slowly by the old method, do not thrive and the difference becomes even more marked. The small farmers of the Maseno district simply cannot afford to have a truly bad year.

One researcher thinks it is worth noting that all of the farmers are now planting wild sunflowers wherever there is room for them, so that there will be plenty to dig in at any given time. And they are also seeing to it that some of the sesbania trees around the village houses are left to grow into real trees and produce seeds, thus enabling the villages to become self-sufficient in this respect.

As far as Suslia and the 768 other test farmers are concerned, it looks as if their phosphorus problem will soon be solved. But for the 10,000 farmers whom ICRAF and the Kenyan researchers would like to see participating in the project over the next few years, there is still some way to go. The one really effective solution would be to bring in bulk supplies of phosphorus from the rock phosphate mines located in various parts of Africa. But that would be an expensive undertaking, and one that the public authorities cannot, as yet, afford.

And the soil is still being mined for all it is worth in many other parts of Kenya, and in Tanzania, and Zambia, and Malawi, and ... ICRAF is going to need international support for many years to come.

AGRICULTURE IS IMPORTANT – FOR A HOST OF REASONS

There are two main reasons why agriculture is of such significance in Africa:

1. The continent produces far too little food for its population, and
2. Agriculture plays a crucial role in the economy of the various countries.

For the food supply and the economy to be improved, agricultural production needs to be stepped up. The most serious problems can be summed up, very briefly, as follows:

An increasingly large number of people in Sub-Saharan Africa survive on an income of less than one dollar per day. Twenty percent of the world's most needy live in Africa, and it is the only continent in which it is expected that poverty will become more widespread in the years ahead.

Poverty will increase and so will the population for many years to come, as far as can be predicted. But food production cannot keep pace. The number of calories consumed per capita has dropped over the past 10 to 15 years. In 1997, Africa imported about 9 million tons of grain, but untold numbers still suffer from undernourishment or malnutrition. By the year 2020, it will be necessary to import 30 million tons.

This in itself is a serious problem. Importation on such a scale would foster a crippling dependence on the rest of the world. Africa would face the risk of supplies that fluctuate drastically with the rise and fall of grain reserves on the international market.

It is also difficult to see where the money for such massive imports would come from. Just as it is hard to comprehend how, from a purely practical point of view, it would be possible to distribute those mountains of grain to all parts of the continent. It is hard to imagine how a reliable food supply can be achieved unless Africa's own agricultural system is given a powerful boost.

In order to turn the tables in the race between the growing population and dropping food levels, agricultural production must rise by at least 4 percent per year. Today, only a few countries that are doing really well achieve this rate of growth.

But agriculture is not only the most vital source of food in Africa, it is also the prevailing way of life for the people of all its countries, if one does not count South Africa. An average of 70 percent of the population lives by farming, and 40 percent of all exports are earned from agricultural products. One-third of the national income in Africa is generated by agriculture. And, lastly, it must be borne in mind that the poorest members of society are the ones who are most dependent on agriculture for jobs and income.

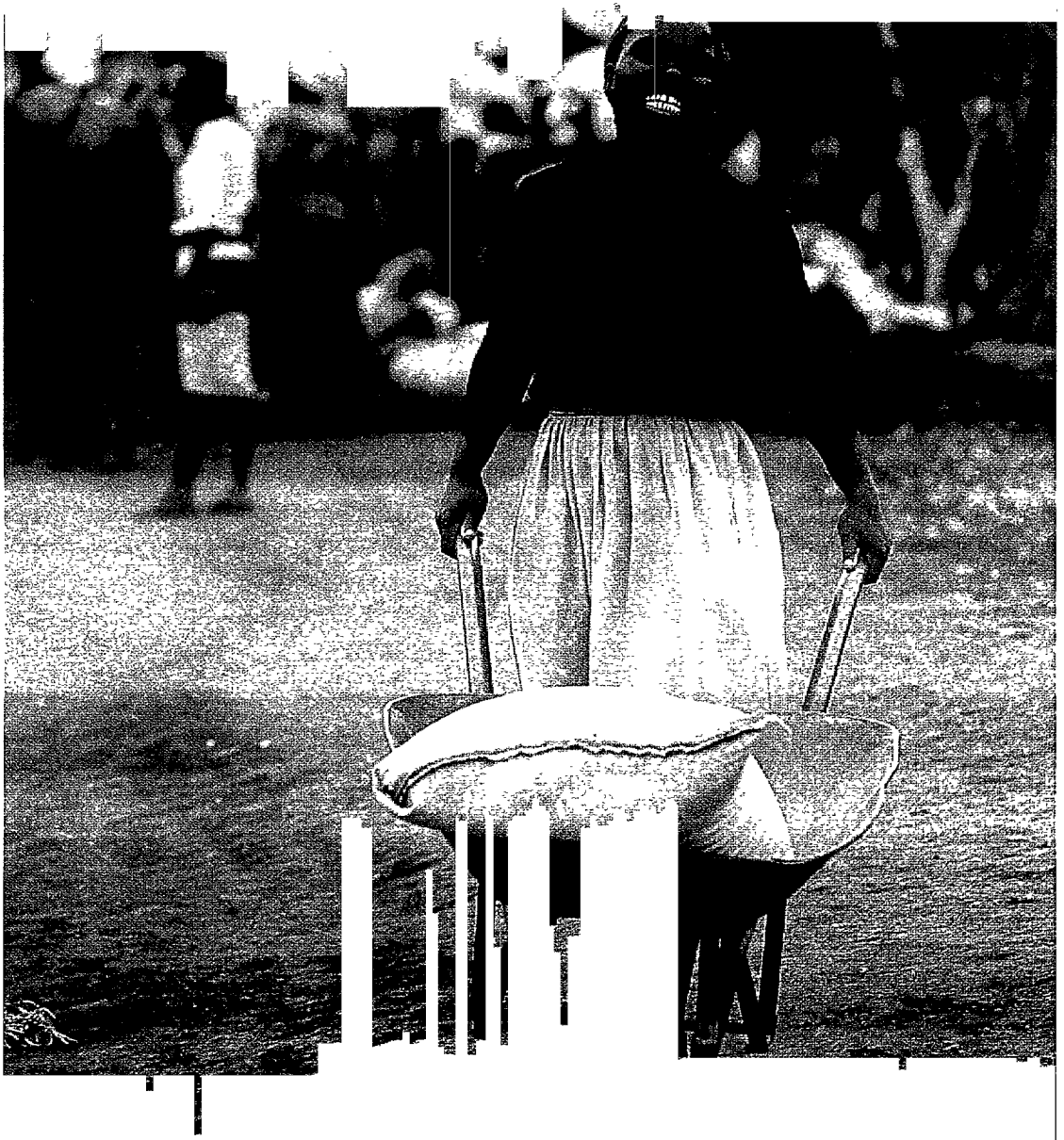
But with so many of the rural population living below the poverty line, spending power is also minimal; increased productivity levels do not automatically mean more money in the pockets of efficient farmers. Poor roads, unreliable transportation, and a shortage of buyers can often make it difficult to dispose of produce outside of the local area. In such a situation, more merchandise in the local market simply means that the farmers are faced with lower prices, and what incentive is there, then, to increase production?

But it does pay to do something about these problems. Whenever money is made on sales to neighboring regions or for export, farmers will spend the extra cash locally. They buy other farmers' produce, purchase goods from neighborhood craftsmen, take on farm hands, and embark on new building projects. Studies carried out in some African countries have shown that every dollar coming into an isolated rural area from the outside world can generate a turnover of up to three times as much.

Growth can be boosted still further if the farmers can switch to producing crops and commodities that fetch a higher price – vegetables, fruit, milk, and meat, or coffee, tea, cocoa, and flowers for export.

And the farmers can do even more to improve their lot by forming self-help groups. Help and advice can more readily be passed on to them, they can support one another, and borrow equipment and money through the group.

There are a whole host of different development tasks. But the aid of local authorities, private enterprise, and independent organizations, as well as international development assistance, is needed if these are ever to be fulfilled.



To grow green, the maize must wither

Zimbabwe

Two researchers are standing in the middle of a maize field, deep in discussion. It is all conducted in the most polite, most considerate fashion, but they are clearly having a strong difference of opinion. One intends to stop watering his maize that Friday, while the other turned off the tap at his research station two weeks ago.

In both places the maize is still green and lush, long before it even begins to put out flowers or ears. And then the researchers cut off the irrigation, in the middle of the dry season, when one could almost bank on the fact that there will be no rain for another four months.

It sounds harsh. The point at issue is whether it is, in fact, harsh enough to kill off enough maize plants. One researcher expects only 50 percent to survive. The other believes they have to get the figure down to 25 to 30 percent. Otherwise it is simply not good enough. The problem is that neither of them has had any practical experience as maize executioners, and being a researcher working on such a new approach usually means following one's nose.

What the researchers are endeavoring to reproduce at their research centers is a really poor year for maize. They do not want to achieve a high yield. What they are out to ascertain is which of all the varieties available for research are worth putting more work into, in an effort to build up a resistance to drought. In the process, they are planning to snuff out quite a few of those varieties that the seed producers are always boasting about. While these are capable of a great deal, they cannot do much without rain.

A number of the seed producers' fine varieties can be used by the large-scale farmers, who, by twiddling a lot of knobs, can ensure a decent yield in most years: through irrigation, fertilization, insecticides, and weedkiller.

But that knowledge is of little use to smallholders in the country's most drought-ridden and depleted tracts of land, where the maize crop in an average year amounts to less than a fifth of what the big farmers can manage. In a bad year there is no crop at all.

Researchers debate how to mistreat the maize, so that only the hardiest varieties will survive and move on to the next stage in the cross-breeding process

Forget the maize

The simplest advice to the small farmers would be to give up growing maize, since it is so difficult. Such a strategy would help to some extent, inasmuch as there are other crops, such as the tuberous cassava plant and the smaller grains, millet and durra, that are better able to survive the bad years. Currently under development are some new varieties of these crops, even hardier than the traditional strains, so in the future the fluctuations in the harvest should not be so drastic.

The threshing ground with the harvest stacked up [illegible] little of everything, [illegible] – with luck – a heap of maize ears. The crop often [illegible], however.

But a family in Zimbabwe will still expect to have maize for dinner every now and again; that is how it has always been. And not just any maize either: oh no, it must have just the right taste and color and firmness and be suitable for grinding down into mealy meal without too much effort.

The researchers' charge has therefore been to come up with varieties of maize possessing more staying power. Maize production per capita has been falling steadily in recent years, but demand continues to grow – after all, eating habits cannot be changed overnight.

The harder, the better

This research is being carried out in a vast region of southern Africa. Here, national maize researchers are working side by side with CIMMYT, the International Maize and Wheat Improvement Center, which has a research station in Zimbabwe. Strains of maize are being tested in five countries in the region, in each case using a wealth of different varieties.

The researchers are not, however, starting from scratch. In Mexico, where they have their headquarters, CIMMYT has carried out trial growings of several types of maize in its own fields, located in the parched lowlands of the country. Here, nature has been left to make the initial selection, sorting out the strong from the weak. But just because a certain maize will thrive in Mexico does not mean that it will yield well under the conditions prevalent in southern Africa. Besides, it has to be able to compete with those varieties that are most to the taste of the local people.

At the government research station in the Save Valley, where the researchers were disagreeing on how hard they should be on the maize, 126 varieties are being tested. At another research station in Zimbabwe, Chiredzi, 3,500 varieties in all have been planted in the test field.

At both stations, the maize was planted in May, when the rainy season had long since tailed off and the ground was well and truly dried out. The maize was watered by irrigation to get it started and has been carefully tended ever since. Although the different varieties do vary in height, the majority are growing nicely.

This experiment takes the preliminary selection process carried out in Mexico a stage further. Here, the researchers deliberately set out to hit the maize during flowering, when it is at its most vulnerable. Nothing could be meaner.

Complex plants

The maize plant produces both male and female flowers. In the normal way of things, the female flowers will develop into ears of maize. But for this to happen the maize plants

Such sad sights are, unfortunately, all too common in the drought-ridden regions of southern Africa and will continue to be so until tougher varieties of maize are developed

need to be relatively well nourished at the time of flowering. If not, the plant stops supplying nourishment to the female flowers and gives priority to the male flowers, to ensure that their pollen will be spread to the winds and, with luck, perpetuate the line through a stronger plant.

The presence or absence of rain during the period prior to flowering is what determines whether or not there will be a harvest, and it is that absence of rain that the experiment is intended to reproduce.

Not all plants are equally hard on the female flowers, and it is this distinction that is being put to the test in the experiment. In the Save Valley they stopped watering the plants three weeks before flowering was expected, while the plants at the Chiredzi station will have to go five weeks without a drop of water.

Once the flowering is over, the plants are given a little more water. This pretty well reflects the generally unstable situation regarding rainfall in Zimbabwe: rain does fall during the rainy season, but it may come late or it may come early, and there will almost always be dry spells in between.

Hard work

As mentioned earlier, the maize is still lush and green, and the researchers do suffer pangs, knowing that in a few weeks' time these fields will be a sorry sight. This has entailed quite a readjustment on their part, but they are beginning to develop a new professional pride in their system. By mid-October the outcome of the experiment will be clear. A loss of less than 50 percent is of no great use; it only means having to start all over again, with far too many plants, in the next dry season.

In any case, tests will have to be carried out for a good many years yet in order to come up with varieties that can stand up to the demands put on them by drought, as well as those made by the farmer and the consumer. And those demands are by no means the same in Zimbabwe, Malawi, Zambia, or any of the other countries in the region that are involved in the research.

An untold number of mathematical permutations are employed in the fields, with computers having worked out exactly where each variety has to be positioned in four different plots, next to different plants, round the edges or in the center of the patch. The outermost plants in each plot are not included in the calculations, and everything is done by hand – apart from the plowing – to prevent random factors arising from harvesting or weeding from affecting the final count.

Experiments are also being carried out elsewhere in southern Africa to find plants that can survive in soil containing very little nitrogen. These two experiments will eventually be combined into one, aimed at propagating vigorous plants hardy enough to cope with poor soil and an unpredictable rainfall.

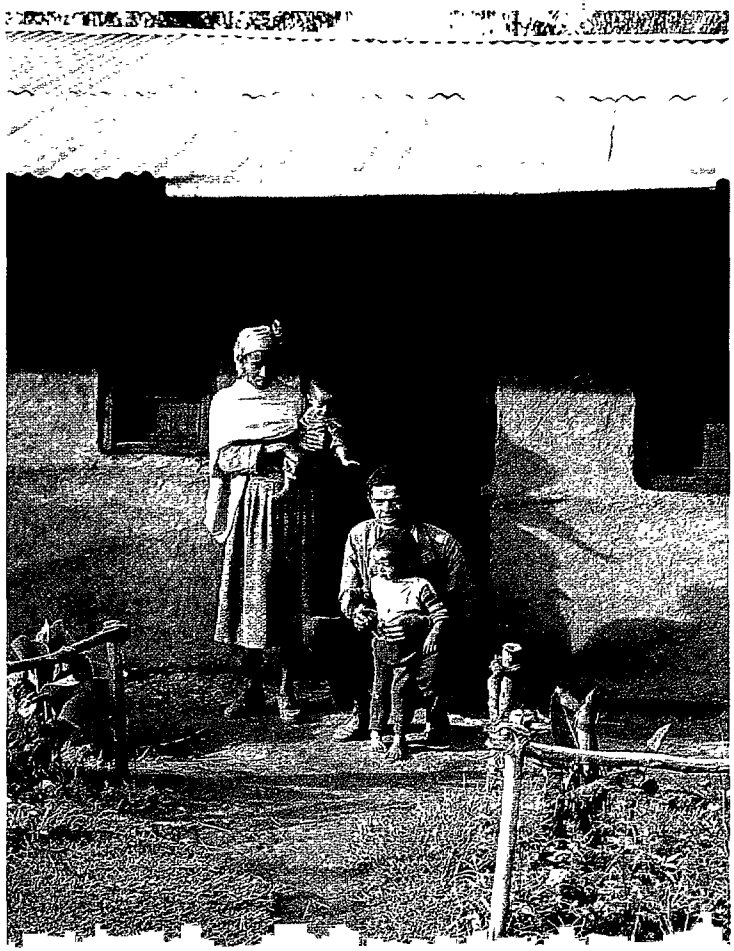
Sometime in the next millennium, some good will come of this research. CIMMYT can produce solid statistics to show how strains developed in the 1970s and 1980s are now being grown in large areas of Africa, where they are able to withstand disease and insects alike, and give a high yield.

But agricultural conditions are constantly in a state of flux, not least because the population pressure forces agriculture to resort to land that is not especially suitable for prolonged crop production. Pests and diseases evolve to the point where they can adopt new lines of attack. The plant propagators in Africa have chosen a field in which there appears to be no prospect of unemployment for many decades to come.

But you don't use cows for plowing

Ethiopia

Plenty to smile about here: two lovely, healthy children, a new house, and, of course, the corrugated iron roof.



In Denmark, not so terribly long ago, you could always tell from a long way off how well a farmer was faring. All you had to do was to count the number of chimneys on his farmhouse roof: three or four and it was a sure sign of a prosperous farm.

In the village of Rob Gebeya, about 75 kilometers west of the Ethiopian capital, Addis Ababa, they have a different way of gauging whether someone is doing well: thatched roof or corrugated iron? The latter is the one to impress the neighbors.

That is the reason that farmer Zediew Beka would rather be photographed with his wife and their two small children in the doorway of their new house, where the corrugated iron roof juts out over the entrance. Two years ago, however, things were looking rather different.

A little farming family

Zediew is 25 years old and attended school for three years. His wife Mestawot is only 20 and has six years of schooling behind her. When they set up home together they had next to nothing Zediew inherited the 2 hectares for the farm from his father and they owned one ox, as a castrated bull is called.

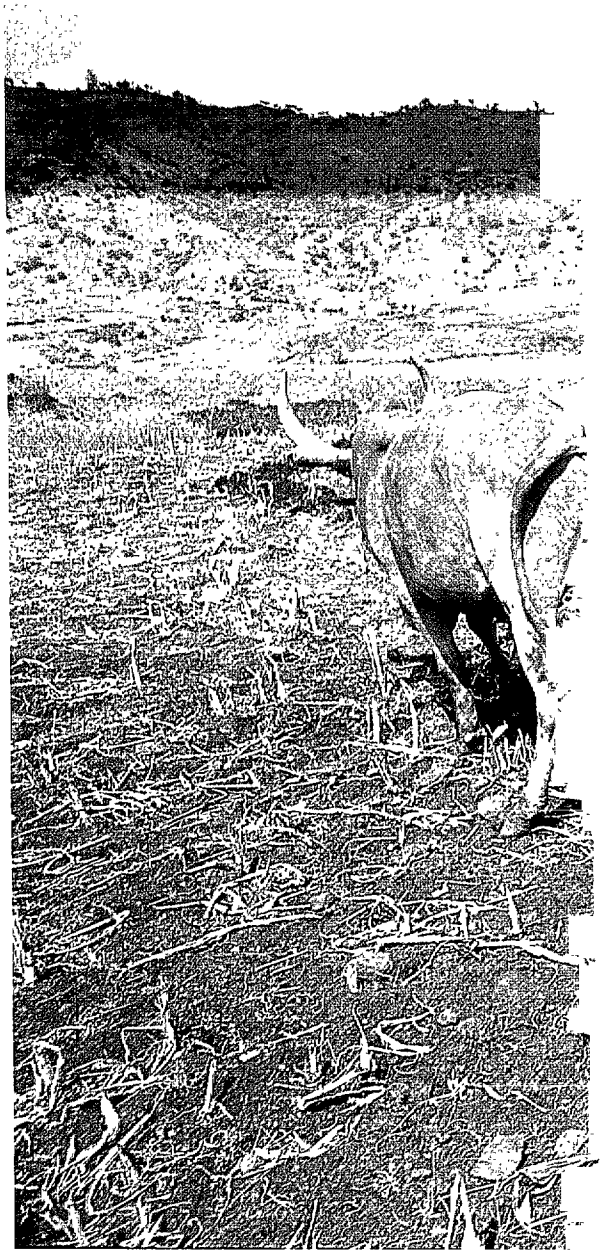
Such a small farm holding does not offer the most promising start for a farmer in one of the most meager parts of Ethiopia. The soil here is not rich, and the rains can be unreliable; sometimes the spring rains that are supposed to see the cattle through the first half of the year, until the start of the long rainy season in June, do not come at all.

And one ox is not enough for plowing; for that you need a pair. So Zediew had to hire an ox. That costs money, a scarce commodity in such a household, and of course the oxen are only available for hire once their owner has taken care of his land.

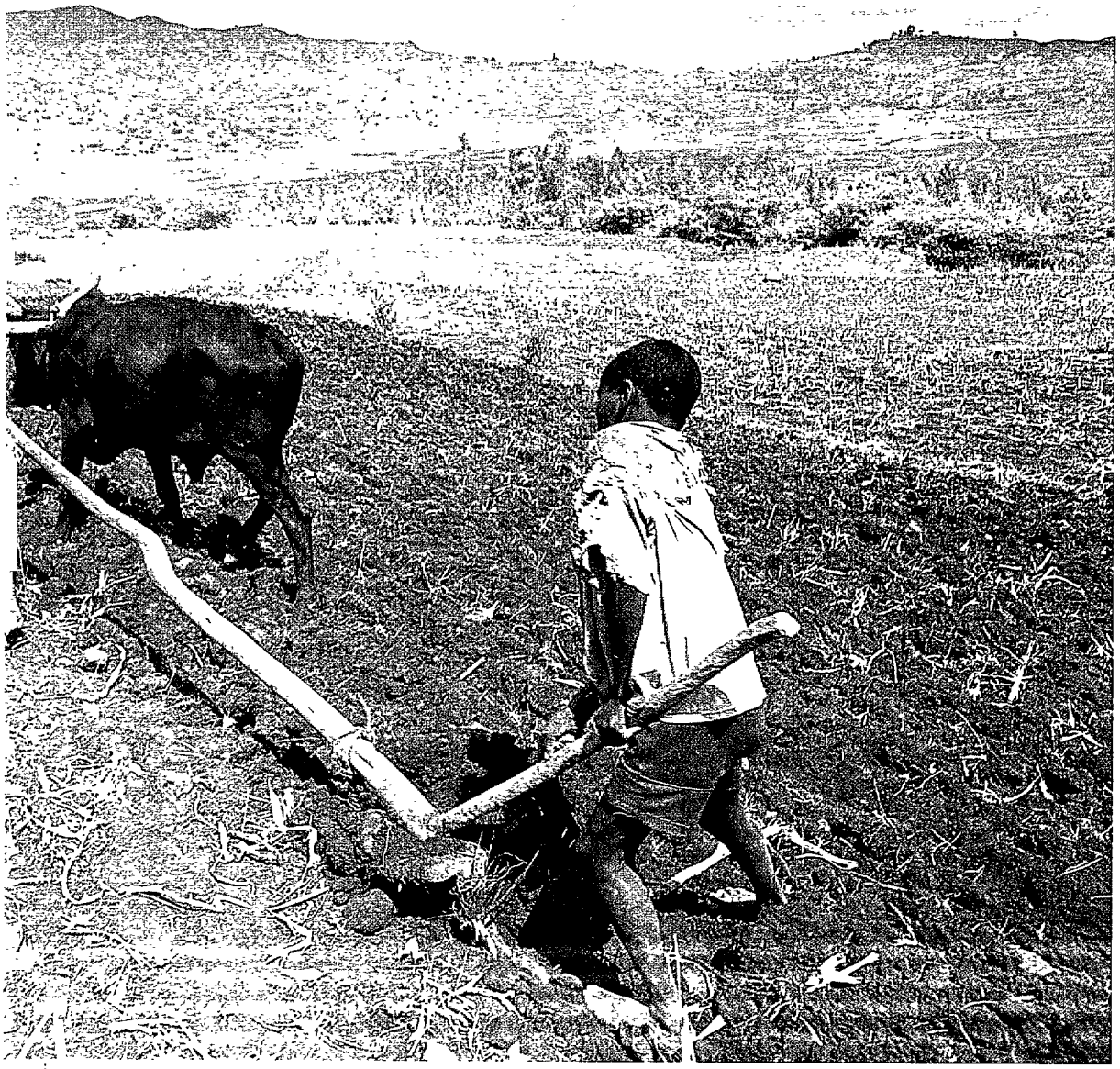
But Zediew had the good fortune to be living in an area where ILRI, the International Livestock Research Institute, was working with Ethiopian agricultural researchers on testing some new concepts. Zediew asked to be included in the experiment, and since then, on the whole, he and his family have not looked back.

Cattle – a mixed blessing

But first, a few facts about oxen and cows in Ethiopia. There are too many of both: about 31 million head of cattle. Of these, 9 or 10 million are oxen, used for plowing and pulling on the farms. The rest are either dairy cows or bulls, heifers or calves. All of these need grazing land in a country where the population is growing at such a rate that there is no longer enough arable land to go round.



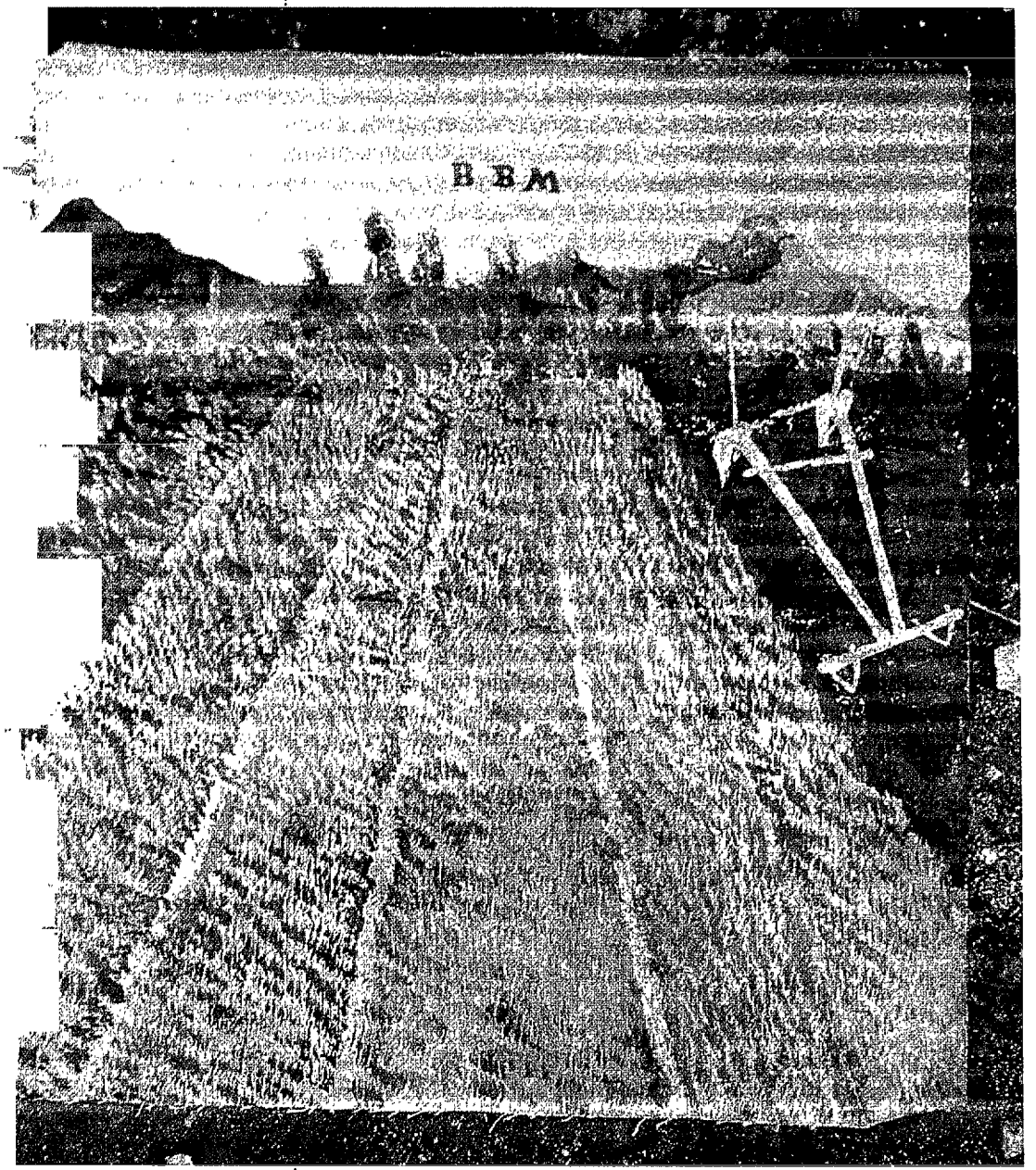
There are many good reasons for keeping cattle on an African farm. They are draft animals; they provide milk



of the planting season.

and butter and cheese; they supply meat and hides and manure for the fields or – as is more often the case – dried dung cakes for the household fires. And, just as important, the cattle are the farmer's bank book on four legs. If money is tight, he can sell a few head.

Keeping cattle also makes sense, since they live mainly off the agricultural leftovers, whatever cannot be used directly by people themselves: straw, grass, the stubble from the harvest, leaves from the trees. In Ethiopia, most cattle are fed nothing else, as one can tell just by looking



at these bony little creatures, which weigh, on average, around 250 kilos – less than half the weight of a well-fed Danish cow. They are put to graze on the village's common land, minded by cowherds from the cool of the early morning until milking time, just before sundown.

The logic is questionable, however, when there are too many animals, producing too little. All told, the oxen probably work no more than two months in the year, mainly plowing, but naturally they eat all year round. As one of ILRI's Danish researchers puts it, "It amounts to the same thing as a Danish farmer having a tractor sitting with its engine idling in the yard day and night and only driving it for a couple of hours each morning and evening." Now of course no farmer can simply kill the engine on his team of oxen, but, with a little imagination, there are other ways of saving.

The new double plow is already such a winner that it has found its way into popular works by local artists.

Good enough in theory ...

Which brings us back to Zediew and the experiment he took part in. The ILRI researchers had been experimenting for some years with using dairy cows instead of oxen as draft animals. Oxen and cows plodded up and down the paths around the research station near Zediew's village for hours on end, pulling test sledges. Different feed mixes were tried out and analyses conducted on milk samples from a breed of cattle sturdier than the local Zebu cows, namely a cross between the Zebu and the black and white Friesian cows. The computers churned out some interesting data.

All the figures showed that there was absolutely no reason why oxen could not be replaced by cows, which never idle. They produce milk and calves even when they are also used to pull a plow. And, as the researchers were able to prove, their milk yield is only about 10 percent less than when they were doing no field work.

... and in practice, up to a point

In 1993 the first tentative attempts were made to see whether these promising results could be reproduced in practice, in the local farmers' own fields. Fourteen farmers were each offered the chance to buy a couple of crossbred cattle at a favorable price with a loan that had to be paid back within three years. But there were some strings attached. They had to agree to use the cows for draft purposes.

This caused no end of a problem and gave rise to fierce discussion throughout the region. Cows just don't pull plows, was how most people saw it. "And why not?" the selected farmers were bound to ask, if they wished to be involved in the experiment. And they very much wanted to be involved, since it was a well-known fact that the new cows could give 8-10 liters of milk per day, while few local cows were capable of managing 2 liters, assuming that they were well-fed.

Another proviso with the experiment had to do with the fodder. The farmers had to promise to plant at least half a hectare of land with a mixture of oats and pulses, and to give over one plot of land to the growing of a richer grass. If possible, they were also to replace some of the hedging around their farmhouses with bushes that would bear leaves full of good nourishment for the cows.

The last condition was really more a piece of good advice: sell some of your old cows and extra oxen to avoid having too many animals competing for the same fodder.

Now, of course, 14 farmers is not a lot on which to base an experiment, so once they were up and running another 50 were selected. At the same time, agreements were reached with 60 other farmers, who received helpful advice and visits from the researchers, just like the test farmers, but no new cows. These would be used as a control group.

A healthy balance

Zediew is one of the 50 new test farmers who made a start in December 1994. Like the others, he was granted a three-year loan to cover two-thirds of the cost of the cows. But before the cows even arrived he had – as stipulated – built a stable for them: this new breed of dairy cow had to be kept inside for the better part of the year. Not only that, but his half hectare of forage was ready for harvesting.

The cows were in calf. Not that Zediew was especially lucky in this instance – they gave birth to two bull calves – but, as promised, the milk yield was high. And 1995 and 1996 were two exceptionally good years. The rains arrived on time, the cows thrived, and the money began to come in. For the first time, Zediew was able to pay for fertilizer for his fields in cash, instead of having to take out a government loan on the strength of his next harvest.

The Bekas' newborn son was given all the milk he could drink and some went to Zediew's father's family on the other side of the village, but the bulk of it was sold off. Although Zediew does not have the precise figures at his fingertips, he has probably made about US$300 per cow from the sale of his milk, as opposed to the $30, or

thereabouts, that one could expect from a local cow.

Obviously there were some outlays. Although the stable was built mainly from branches, straw, and mud, some cement and gravel and a few planks were also called for. The forage from the field did not stretch far enough, so he had to buy a little in the way of fodder concentrate and some extra hay. And then there were the veterinary bills: he could not afford to lose one of those costly cows – not to begin with, at any rate.

Nevertheless, in a good year the profits are healthy enough, and Zediew now has two dairy cows, two bull calves, and a heifer. He has also rented an extra hectare, which means that he can now farm almost 3 hectares using the modern method. We have already seen the house with its corrugated iron roof. Another recent acquisition is Zediew's big cassette player. And there are some new utensils hidden away in the kitchen – his wife's domain, behind the wooden partition inside the house. And then he does, in fact, have two oxen. Oxen? But what on earth is he going to use those for, now that the cows are doing the plowing?

It is a rather complicated business. In Zediew's part of the country – and in fact in most parts of Ethiopia – the villages act as an insurance organization of sorts for those able to become members. In order to join, one must be able to contribute in some way to the association, which offers assistance when a family has difficulties due to sickness, accident, or death. One vital way in which the association can help is through the lending of oxen. Before Zediew acquired his own team of oxen he could not join the association and, therefore, had to hire a team. It is still not considered proper to offer cows to other farmers, even though they are, in fact, stronger and get the field work done faster.

Mixed experience

So the future could be said to be looking bright. Last year was a good year. But this year the spring rains were disastrous and the grass is patchy and lifeless. As a result, all the animals on the farm are undernourished, and there is at least a month to go before things really start to grow again in June. Zediew is having to do some hard thinking about whether he will have to sell one of the bull calves to raise cash to buy concentrates, for the dairy cows at least. The longer he puts off making a decision, the skinnier the calves become, and the lower the price he can get from the butcher.

The long rainy season has gotten off to a good start, so it looks as though the problems will resolve themselves as the year progresses. But there is a limit to the size of herd Zediew can keep. He reckons that he will draw the line at four milk cows. Even if business were to go really well, there is no guarantee that his children will stay in farming; their future might be better assured through a good education.

Looking toward the future, the test farmers will someday have to manage all by themselves. In the first place, the experiment has not led to a drop in the number of cattle. The idea was that the dairy cows should supplant the oxen. As to the question of whether this has been achieved, the answer would have to be yes and no. And a wise farmer will still safeguard himself against the odd bad year by keeping plenty of cattle. Zediew does think that at some point he will probably put his excess income in the bank, rather than into livestock, but so far that is just an idea.

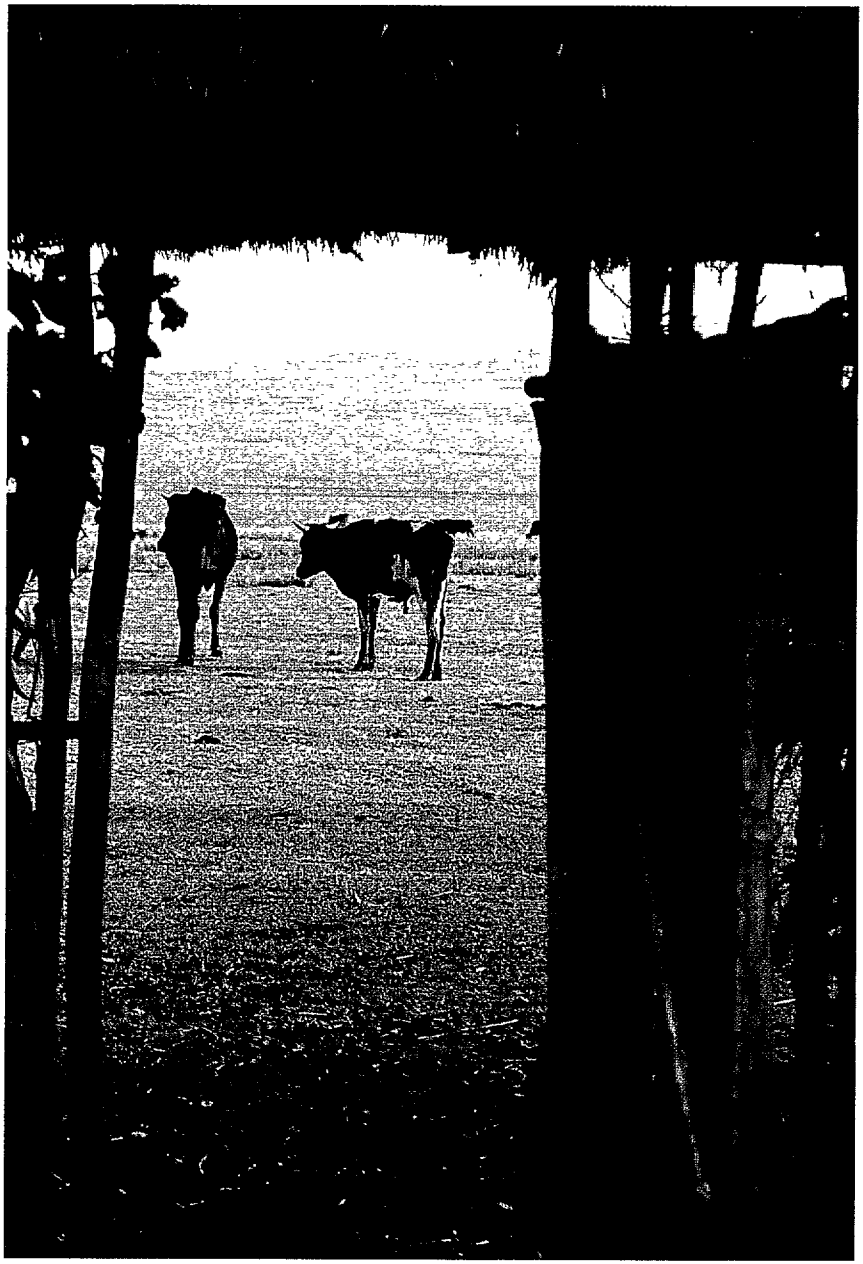
As for the cattle remaining in the area, the researchers are having to do a major rethink. The underlying problem is that, because of the common pasturing, overgrazing caused by excessive numbers of cattle is a collective matter, not one that can be resolved by individual effort in the short term, at any rate. But in the long term, perhaps it can be solved. And they have no doubt that many of the farmers, while experiencing healthy increases in their milk sales, would happily go back to plowing with oxen were it not for their deal with the researchers.

One or two bad rainy seasons might be no bad thing for this specific problem. The competition for fodder is going to become more and more intense, if a lot of those

oxen engines that are simply idling are not eventually turned off.

So far, it has been enlightening to follow the progress of the farmers in this experiment. Almost without exception the families concerned have benefited. But they are soon going to have to stand entirely on their own feet, without the researchers to help make certain that the veterinarian comes when he is supposed to or that there are enough fodder concentrates in the market.

This experiment has ensured that there is more milk for sale in the region, more jobs for farm workers, and more money in circulation. In short, it has been good for the whole area. Researchers in other parts of Ethiopia and in neighboring countries continue to follow the experiment with interest.



In a bad year, when the milk cows start losing weight, they are driven out to the common pasture ground, though there's not much to be foraged from it.

AGRICULTURAL RESEARCH ALONE WON'T DO IT

The stories related in this book show what excellent results can be obtained from well-organized agricultural research. But it will take more than that, if sound agricultural development and a reliable and sustainable food supply are to be achieved on a large scale.

Above all else, it is vital that national and local authorities function properly and that decent policies in support of agricultural development are drafted. In practice, this means – among other things – that farmers should have access to new agricultural technology: new seed varieties, for instance. Inherent in this, too, is the necessity for reasonable buying and selling prices. And farmers must be assured of a dependable delivery service, with supplies arriving on time for each stage in the farming calendar. The farmers need to know that advice is to be had on how best to plan their work; fertilizer, farm implements, grain sacks, milk churns, and the like must be readily at hand.

There are many places where the public advisory service does not function as well as it should, due to a shortage of personnel, of new information, of practical experience drawn from the local test fields, and, not least, of the transport necessary for making timely seasonal visits to the farmers. The advisory service must, therefore, be rendered more efficient, and the farmers' own knowledge base must be enhanced by means of better and longer schooling.

The agricultural community has to be able to purchase agricultural supplies and to sell off its agricultural surplus, and both sides of this market need to be improved. In many countries, the state has assumed responsibility for buying and selling in the agricultural sector. In the majority of cases this has led to systems that are unwieldy, expensive, inefficient, and strictly regulated. In most countries the privatization of this area is already under way, and steps must be taken to ensure that this leads to reliable and efficient systems in which open competition will set reasonable price levels. If the market is working well, this in itself can give a considerable boost to food production.

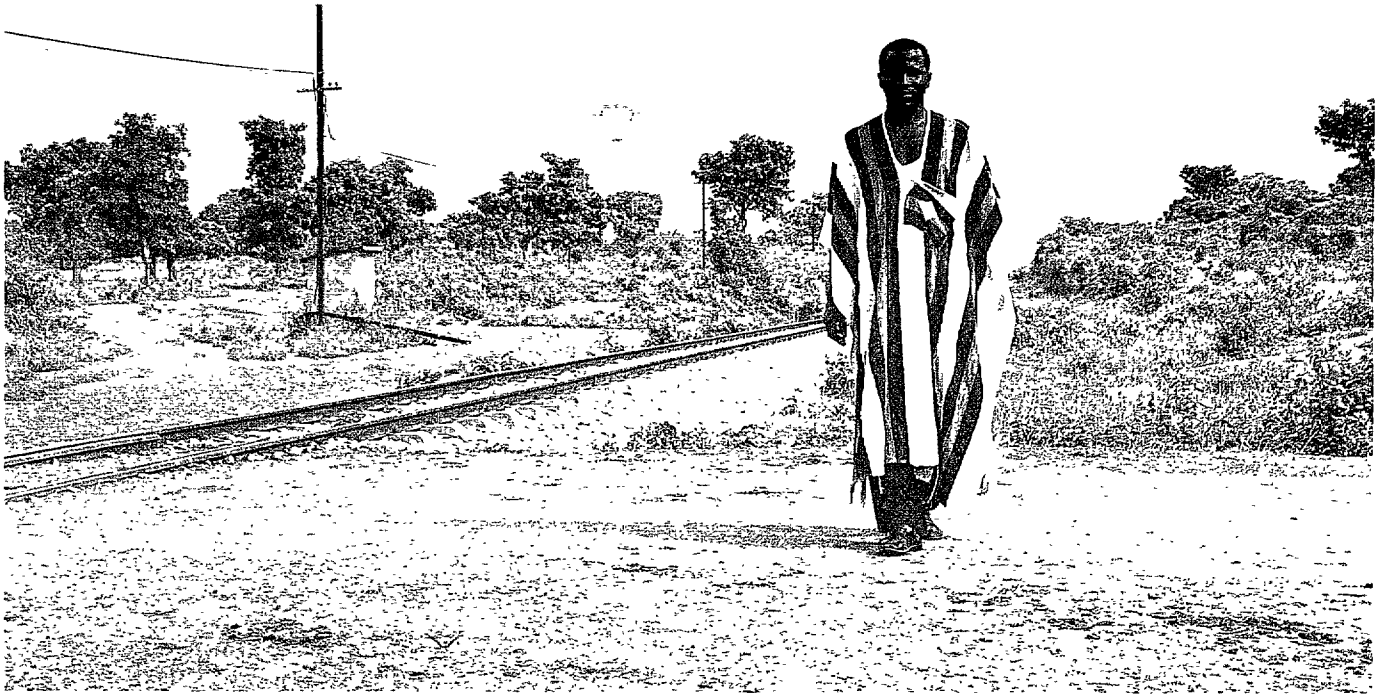
Government authorities can reinforce agricultural production by building and maintaining a road system designed to guarantee a dependable transport service to and from the rural areas. There is a need for decent storage facilities and a reliable communications network (telephone, fax, and so forth), in order that goods and transport can be ordered as they are needed.

Another vital task involves making it easier for farmers to obtain loans from banks and credit unions, thus affording them the wherewithal to make improvements on their farms. In many countries this will require a relaxation of the rules that dictate who can be granted a loan and how to apply for one.

One major, and problematic, area is the environmental side of agricultural production. Clear rules must be established as to who has the right to use natural resources, such as water, forests, trees, and farmland. It will be up to the authorities to make certain that these rules are respected and to involve individual farmers as well as the local community in the work of restoring and preserving land that has been degraded and rendered almost useless for agricultural purposes. Unless each and every village understands the importance of this task, the process of degradation will simply continue.

In the days when there was still plenty of virgin country suitable for farming, the land was common property and the right to work it amounted to a right of use. As agricultural land has become more scarce, the need for a better way of allocating it and of establishing who actually owns it has arisen. This question of land allocation is fraught with problems. Large-scale farmers can own so much that smallholders and farm workers do not contribute enough to agriculture. And the right of use can be so tenuous and so short term that the farmer sees no point in spending money on improvements, for example by planting windbreaks, constructing terraces, or using fertilizer. In the interests of food security it is absolutely essential that the powers that be in the countries of Africa implement viable land reforms over the years ahead.

One vital factor in all of the above-mentioned reforms and improvements is that women be accorded the same rights and conditions as men. In the majority of African countries the number of women farmers is roughly equal to the number of men, while in many places the women are clearly in the



majority. And in every country, women do a great deal of the work on the farms, even where it is men who own the land. The advisory service, banks, buyers, and local authorities must, therefore, adopt exactly the same approach toward women as they have toward men, if women's efforts are to be turned to good account.

Many of the tasks mentioned here are obviously of relevance to the society in general, stretching far beyond the bounds of the agricultural community. Likewise, it is essential, both for agricultural development and for security of the food supply, that general reforms within the spheres of health and welfare, family planning, civil rights, and education be fulfilled in such a way that the effects will be felt by society at large in Africa.

Getting the rice right

Côte d'Ivoire

Silue Fahasseli ponders the question he has just been asked and looks at his wife, Kone Figue, who helps him add up. How much land do they have? Well, there is the field of cotton, and the maize patch, a small plot containing groundnuts, and then there are the yams, which, as it happens, have just been planted, now that the May rains have come. That makes about 3 hectares of land. Oh yes, and then there is another 3 hectares of rice. It is the rice we are here to talk about.

In the village of Ponoundogou in the northernmost corner of Côte d'Ivoire in West Africa, they are not really in the habit of counting how many hectares of land they have. They are not short of farmland here in the savannah belt. Villages and cultivated fields are in fact few and far between; the land is state-owned, but may be used by anyone who lives here. Clearing new ground is hard work, so there is a limit to the amount of land each family can farm. Keeping the fields free of weeds is almost as arduous a task. Which brings us back to the rice.

Rice has been grown in Africa for at least 3,500 years – not the varieties of rice that are grown in the low-lying plains of Asia, where fields are flooded and the rice slops about in water for most of its growing season. Those varieties did not reach Africa until about 500 years ago, introduced by Portuguese merchants. The indigenous African

The cross between the African and Asian strains does not allow the weeds much scope, and the tall, sturdy stalks make this rice a favorite with the village women

rice gets by on rainwater and is sown in the same, familiar manner as other grains. It does well here on Côte d'Ivoire. It can take most of what the climate has to offer and is resistant to numerous diseases and harmful insects. But its yield is not what one might call impressive.

Silue and Kone sell off their cotton; they eat most of the maize themselves and give a little of it to their two cows. Most of the groundnuts, too, are for sale, though some add a little spice to family dinners. But what a large family like this, with six children ranging from the ages of 6 to 23, really wants to see on the dinner table is rice. The rice in their small circular storehouse does not stretch to a whole year, and so, toward the end of the season, they have to make do with the yams and cassava, which resemble huge potatoes.

Since the African rice gives such a low yield, almost everyone in Ponoundogou has eventually taken mainly to growing one of the imported Asian varieties that do not grow in flooded fields. But not every year is a good year. Far from it: the rains may fail, or an outbreak of some serious plant disease may occur, or insects may attack. In such years one would do better to stick to the African rice. A wise farmer grows a little of both, as do Silue and Kone.

Damned weed

But to get back to where we started – with the weeds. In the fields around here, the weeds we are talking about are not benign little plants like dandelions or buttercups or ground elder. They are stout thistles, coarse grasses, large thick-leaved plants with tough stalks, and little bushes that in next to no time can produce a powerful, deep-reaching root system that chokes everything in sight, if regular, thorough weeding is not carried out.

And weeding in itself poses a major problem, with farm labor so scarce. Everything is done by hand and hoe, and even though the children do their bit, it is still touch and go. It takes 40 days of sweating and straining each year to keep just 1 hectare of land weed-free. Well, actually, it is mostly the women who do the sweating and straining. They see to the weeding and the harvesting; the men clear new land and sow the rice.

One of the other farmers' wives in the village, Sitionon Chionfoungo, has a slightly easier time of it with the weeding, because in her family there are two wives to share the work. But there, too, they have their battles with the weeds. And that is one good reason why the African rice is still popular: it is a speedy grower and in no time at all can spread into a whole little bush of densely packed leaves, which cover the soil and overshadow the weeds, making it hard for them to grow.

But, as mentioned previously, this rice does not yield a great crop, no matter how carefully it is tended, not even when given plenty of manure. This particular strain of rice does not produce very many grains per plant, and if its growing conditions are improved, it simply puts out stronger shoots and leaves.

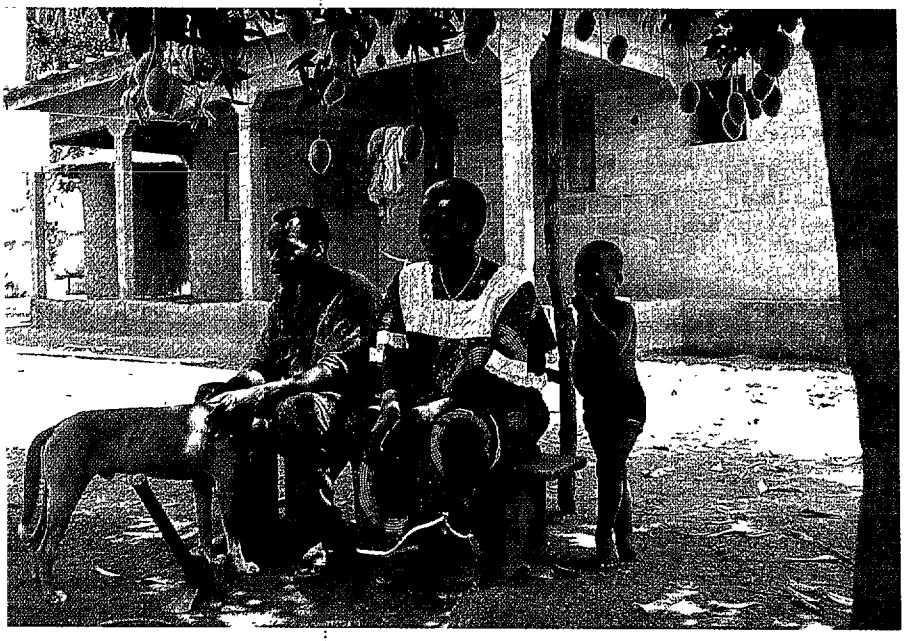
On the one hand ...

A good many bad things can be said of the African rice. It has the unfortunate knack of shattering, so that some of the barely ripened grains of rice fall onto the ground and are lost before they can be harvested. And the stem is so thin that it will often snap or be bent by the wind and rain. And some of the rice, down in the shade between the leaves, may not ripen. The seed also takes a long time to germinate after sowing. But the grains are fine and the rice tastes good.

At WARDA, the West African Rice Development Association, they have been working for some years on the improvement of African rice. But there is a definite limit to how much can be achieved, and so there has been no great interest in pursuing that particular avenue.

... and on the other

But then again, a lot of work has been invested in adapting and improving the Asian rice varieties. The idea has, in fact, been to reproduce the excellent results achieved in



This picture of Silue and Kone under the shady tree in the farm yard was clearly taken during the dry season; otherwise, at this time of day, they would be in their working clothes

Asia, where record harvests have been produced, year after year, from the 1960s right up until recently. The same formula was applied at WARDA: new varieties and plenty of fertilizer, water, and insecticides where necessary to combat diseases and insects. Only about 20 percent of the farmers in West Africa have been able to follow this method.

Over the years the Asian rice has also been rendered more resistant to disease and insects, though it is still not as hardy as its African counterparts. And the Asian varieties did not help at all with the weed problem. On the contrary, they grow tall, slender, and well spread out, allowing their rivals plenty of scope. Consequently, the fields had to be sprayed with weedkiller if there was to be any hope of attaining the splendid returns that can be gained from the Asian rice.

This was never an option for smallholders, and so they had to make do with poorer returns and a little of each of the two types of rice in their fields. But there was never a question of whether to grow rice, because in many countries in West Africa, rice is the staff of life. Indeed, it is quite astonishing how much rice is consumed. In Côte d'Ivoire, it works out to 67 kilos of rice per person per year. In Ghana the figure is as high as 110 kilos and in the tiny country of Guinea Bissau, 135 kilos: an African record.

But these countries are by no means capable of producing all of this themselves. Of each 10 kilos eaten in Côte d'Ivoire, 4 kilos are imported. And the pattern is more or less the same for the rest of West Africa, which, as a whole, imports more than 6 million tons of rice per year. It is hard to picture such a mountain of rice.

Clearly, then, the rice researchers have more than enough to do.

Farmers who know what they want

Silue does not have to think too long before giving his view on what makes a good rice plant. It must be able to flourish without the aid of fertilizer; it must be capable of coping with a dry year; and of course it has to provide a decent yield. Kone expects other things from it: the rice grains should be large, the panicles firm, and the plants tall. It is she who does the harvesting, and it is back-breaking work, bending to cut off the ears with the sickle. Besides, tall rice plants are generally believed to produce a good crop.

Their neighbors are of much the same mind. Coulibali Donignon is the man of the house, or houses one should perhaps say, since there is one for each wife. He emphasizes the importance of tall plants, large grains – because these make the best eating – and fast-growing rice, so that the gap between using up and replenishing rice stocks will not be so long.

But what about weed control? Well, it almost goes without saying that this is most important if one knows anything about farming. Their neighbors sitting in the shade of the tree do not take much part in the conversation, but they do nod in the right places. They are largely in agreement.

But not entirely so, and certainly not when it comes to the order of importance. This is something that the researchers at WARDA know a good bit about, because the village of Ponoundogou is one of those places where something radically different is happening in rice research.

An almost hopeless task

When a new generation of international researchers joined WARDA in the early 1990s, they went right back to the beginning. Not that the improvements already made on the African and Asian varieties of rice were less than successful, but they never led to any real breakthrough. So the new researchers set themselves the goal of cross-breeding the Asian and the African strains in an attempt to get the best out of both types. One might think that that would be easy if one knew nothing about crossing plants. In fact, it was a major undertaking, and there were many times when things looked far from hopeful before a successful outcome was reached.

The researchers began by collecting seeds from all of the varieties of African rice they could lay their hands on, from other research centers throughout the world and from WARDA's own seed collection. This gave them a grand total of 1,500 varieties. Since there were many of these about which little was known, they were grown in trial plots and descriptions of each entered in a large catalog. One long page was devoted to each rice plant, giving 47 facts concerning height, thickness of the stem, how many leaves it was capable of producing, how quickly the seed germinated, the length of the panicle, the number of grains, the size of the grains, their color and shape, and of course how it tasted. This catalog also included a great deal of other information, chiefly regarding how well the plants grew and how well they thrived with and without fertilizer and with limited amounts of rain.

Much was already known about the Asian rice. Not least by WARDA's colleagues at the International Rice Research Institute, IRRI, in the Philippines, where they have well over 100,000 seed varieties at their fingertips.

A selection was thus made from among the most promising plants possessing several good qualities from each of the two types that seemed likely to thrive in West Africa. These then had to be crossed this way and that, to bring out the very best in the new plants. There really should be many different plants to choose from, since their performance can vary greatly from place to place in a region as vast as West Africa, with so many different types of soil, different patterns of disease, different insects, and wide variations in the amount of rainfall. Now the hard work really began.

If the pollen of female and male rice plants is mingled, this will, as a rule, result in plants bearing grains of rice. But, as the researchers discovered, these cannot germinate. And that, one might think, would be the end of that. Not, however, at WARDA, because the researchers there knew that in nature, such cross-pollinations do occur now and then. Hence, over the course of the thousands of years in which wild and cultivated species of rice have been in existence, a major process of regeneration occasionally occurs. Researchers can cite instances of this also having been achieved in the laboratories.

So it was simply a matter of perseverance. And sure enough, a tiny percentage of hybrids was induced to germinate in the next generation. The offspring were a little on the spindly side and most of the plants were the exact image of one or the other of their parents, but a handful in each test turned out to be a mixture of both. All efforts now had to be concentrated on

WARDA advisers and farmers hold regular meetings in the villages to discuss the new rice.

With two wives to share the work of weeding and harvesting, Mr. Donignon can farm more acres than his neighbors.

these, but there is no denying that it was a slow process: the new plants had to be tended through several generations to make them hardy enough to survive in the outside world. And a rice plant takes at least 120 days to ripen.

More good ideas

The researchers therefore cast about for ways of speeding up the process. Other researchers in China and Colombia taught them techniques that enabled them to make direct crosses between the seedlings after only a few weeks. Granted, this meant that they had to develop certain substances in which the plants could grow, but this too they succeeded in doing. Within just two years, they had a small selection of plants ready for use, something which, with the old methods, would have taken at least five or six years.

While all this was going on, work was also being done to improve the parent plants, and the selection process itself was made more exacting. Then the fun really began. Alright, so that might not be exactly the word that the

researchers would use, but one can tell simply by looking at them that that is what they are thinking.

In the spring of 1996 they rented fields from farmers in Ponoundogou and a number of other villages and employed people from the villages to work them. Sixty different varieties were planted: two small plots for each variety, one with and one without fertilizer. African and Asian varieties were used, plus 10 of the new hybrids.

In Ponoundogou more than 60 families were invited to take part in the three-year experiment. During the first year they watched from the sidelines. But once the plants were growing nicely, the villagers were shown round the fields to see how well the new rice had fought off the weeds and how all the field work was being done by local people, by hand as always. The next general guided tour was given once the plants had produced ears and it was possible to see how well they had withstood the weather, insects, and disease. The final presentation was held at harvest time.

Throughout the proceedings, all of the farmers – men and women alike – were interviewed separately regarding their views on the 60 varieties. Each had picked out his or her favorites. A note was also made of the reasons for their choices. After the harvest farmers were allowed to select seeds from those varieties that they considered best, as many as five different types, but only half a kilo of each, or a kilo at most – the experiment could run to no more. This rice was then stored away at home, and in the summer of 1997 it was sown in the farmers' own fields.

It is the fruits of this harvest that Silue and Kone, Coulibali and Sitionon show off and describe. Each of the four has chosen their own varieties. Things have not worked out quite as expected, with the result that one or two of the selected varieties will not be grown again this year. But they are convinced that the new varieties are better than the old and they will persevere with most of them. And this year they will have to buy the rice they sow – so now the work begins in earnest. At the end of the year, once the figures from the November harvest have been added up, it will be up to the farmers to determine how things should develop.

Plenty new under the sun

The researchers have made a radical break with tradition. Previously, they would have spent years working in the test fields back at the research center before finally selecting a couple of new varieties, "the cream of the crop," which could then be offered to the farmers. In this case, all the options are presented and the farmers themselves make the selection. In Ponoundogou in 1997, they grew a total of 19 varieties. Some were rejected as the test progressed, since the taste, the cooking time, the color of the grains, and the ease with which they can be ground down into flour also have to be assessed under actual conditions.

This is the entire "machinery" owned by the average smallholding in West Africa. As can be seen, a hoe is not merely a hoe.

No surveys have yet been made of the yields obtained by the farmers: the tiny plot of land that can be sown from a packet of rice seed is not enough on which to base any scientific statistics. But on WARDA's test fields it is easy to see what can be achieved, with and without fertilizer. The new hybrids consistently yield considerably more than their parents, even when no fertilizer is used – as is usual in Ponoundogou. If fertilizer is applied, the new varieties can easily match the best of the Asian strains.

But the new varieties also have all the good points that each of their parents boasted: tall sturdy stems, dense foliage at the foot of the plant, speedy growth, no shattering of unripe seeds, and resistance to many common diseases and insects. The new plants also cope well with dry spells. And believe it or not, they have their own built-in scarecrow: the spiky leaves at the very top form a circlet that sticks up into the air, making it hard for the birds to get anywhere near the grains. It is doubtful whether the researchers considered this side-effect when they selected the plants. Nonetheless, they are justifiably proud, even of this last little touch.

CGIAR research institutions*
discussed in this book

* All of the international research institutions mentioned in this book – with the exception of ICIPE – belong to the Consultative Group on International Agricultural Research – CGIAR for short. More than 50 countries and organizations are members of the group.

Sixteen research centers come under the aegis of the CGIAR. The examples cited here serve to illustrate a small part of all the work carried out at the following centers, their regional research stations, and collaborating national research systems.

CIAT – Centro Internacional de Agricultura Tropical – has its headquarters in Cali, Colombia. It conducts research into better agricultural methods in the rainy regions of the tropics, concentrating mainly on research into beans, cassava, and tropical grasses for use as fodder. Biological – and nontoxic – pest control also constitutes an important part of the center's work.

CIMMYT – Centro Internacional de Mejoramiento de Maíz y Trigo – has its headquarters outside Mexico City, Mexico. It specializes in research into the propagation of wheat and maize and the development of better methods of cultivating these two crops.

CIP – Centro Internacional de la Papa – has its headquarters in Lima, Peru. CIP concentrates primarily on research into potatoes and sweet potatoes, but work is also carried out on other root crops and local food plants from the mountain regions of the Andes.

ICRAF – International Centre for Research in Agroforestry – is based in Nairobi, Kenya. It studies the uses of trees and bushes in agriculture. This center does much to further the preservation of farmland and the nutritional content of the soil.

ICRISAT – International Crops Research Institute for the Semi-Arid Tropics – has its headquarters in the state of Andhra Pradesh in India. It conducts research into agriculture in the semi-arid regions of the tropics, the main subjects for research being the two grains, millet and durra, and leguminous plants.

IFPRI – International Food Policy Research Institute – has its headquarters in Washington D.C., USA. It identifies and analyzes alternative national and international strategies and policies for meeting the food needs of the developing world on a sustainable basis, with particular emphasis on low-income countries and on the poor within those countries.

IITA – International Institute of Tropical Agriculture – headquartered in Ibadan, Nigeria. The Institute works on the propagation of a number of typical African crops, cassava, bananas, soya beans, and maize; the development of improved agricultural systems; and research into biological pest control.

WARDA – West Africa Rice Development Association – is located in Bouaké, Côte d'Ivoire. It focuses on generating technology for intensified rice-based cropping systems in West Africa, in order to improve the welfare of poor farming families and conserve and enhance the natural resource base.

ILRI – International Livestock Research Institute – has its headquarters in Nairobi, Kenya, and a very large research station near Addis Ababa in Ethiopia. ILRI carries out research into the breeding of productive and healthy livestock, especially cattle, and does a great deal to help combat the major cattle diseases, for example, through the development of vaccines.

ICIPE – International Centre of Insect Physiology and Ecology – is based in Nairobi, Kenya, and is independent of the CGIAR. It conducts research into the control of pests in the tropics; in particular, of those affecting livestock farming, but also of a few insects liable to transmit disease to human beings.

(Addresses for these institutions are on the next page.)

For further information about the CGIAR centers discussed here:

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Centro Internacional de Mejoramiento de Maíz y Trigo
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