

# ICRISAT

## Eastern and Southern Africa 2009 Highlights





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ICRISAT–Nairobi  
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*Photo credits: All photographs were taken by ICRISAT staff members at the various locations.*

*A woman farmer bends to take a closer look at the groundnut in Nalifu village at the foot of Mt. Mulanje, dubbed 'Malawi's Island in the Sky'.*

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## Preface

It is unarguable that the world has changed in significant ways as a result of advances in science and technology. How we do business today is very different from that of twenty or even ten years ago. This is also true for farmers in Eastern and Southern Africa, who have had to adapt to new challenges and respond quickly to new opportunities as they present themselves.

The 2009 Annual Report for Eastern and Southern Africa portrays one such entrepreneurial farmer in Kenya who has evolved with the times and found a recipe for success through the use of improved varieties of pigeonpea she obtained from ICRISAT.

Seed isn't a new technology but it is one of the factors most limiting farmers' advancement in Eastern and Southern Africa. This report describes work at the molecular level that will help ensure the purity of certified seed of groundnut and pigeonpea. It also captures the early steps to kick-start the seed industry in Zimbabwe by increasing the availability of foundation seed and the efficacy of relief programs operating in the country.

GIS and remote sensing have changed how we view the world and increased our ability to monitor changes over time. The final story on land degradation showcases the type of research that is needed to secure one of the most basic and fundamental farming requirements – land.

This report describes not just the impacts of our work but also the technologies and the processes involved in agricultural research. We hope that these stories reveal the layers of work that lie behind achieving impact in farmers' fields.



William D Dar

Director General



Said Silim

Regional Director for  
Eastern and Southern Africa







# Highlights



## Of pigeonpea: Results of growing pigeonpea in ESA



### Money makes money

When Priscilla Mutie bought her dairy cow she knew right away what to call it – *Wanzuu*, which translated into English means ‘of pigeonpea’. Mutie bought her aptly named dairy cow with the KSh 30,000 (USD385) she earned selling pigeonpea.

Now every morning her neighbors in Muuni village in Eastern Kenya stop by her house to buy milk. *Wanzuu* gives her 20 liters a day and Mutie sells the milk for KSh 40/liter, earning an additional USD10 per day.

Mutie wasn't always a farmer. She began dabbling in farming as she reached closer to retirement and needed an alternative livelihood option. In 2002 Mutie received seeds of improved pigeonpea varieties from ICRISAT. However, she was still

teaching at the time and didn't grow the pigeonpea in a large area. But in 2004, Mutie retired. She then began to concentrate on her farming full time and that is when she realized the value of the improved seed she had received.

On the ten acres she works on, Mutie intercroops pigeonpea with a variety of other crops such as maize and beans. Eastern Kenya can be dry and rainfall here as in the rest of the SAT is unreliable. “Pigeonpea resists drought. When I planted pigeonpea and maize I saw that the pigeonpea is more



*Priscilla Mutie shows off the newest addition to her herd – Wanzuu's baby.*



*Standing in her pigeonpea field Priscilla Mutie is all smiles. "Farming is the best option for me," she says. Money earned from pigeonpea sales have allowed her to recently dig a well, ensuring a reliable supply of water for her family and her fields.*

resistant to drought than the maize. This made me choose pigeonpea as my crop for sale. I buy the other crops with the money I earn from selling pigeonpea. One kg of pigeonpea is equal to around three kg of maize," Mutie says.

### **ICRISAT's input**

ICRISAT gave Mutie seed of two long-duration (ICEAPs 00040 and 00936) and one medium-duration (ICEAP 00557) pigeonpea varieties under the Treasure Legumes Project. Of these varieties Mutie likes ICEAP 00040 because it is sweet in taste and ICEAP 00557 because she gets her harvest early and can both eat and sell while there is no pigeonpea in the market. ICRISAT, through the Lucrative Legumes project, also provided her with training on seed production and the importance of finding better markets for her products.

And it is obvious that the lessons stuck. Mutie's success lies in her entrepreneurial spirit. Pigeonpea can be eaten green, like peas, or it can be shelled and dried and then cooked. Just like peas, it can be sold in pods or shelled, with the prices for the shelled being higher. When Mutie sells her shelled pigeonpea in the nearby market of Emali she gets KSh 100/kg. While this market may occasionally prove lucrative, it is also very quickly saturated with Mutie's neighbors also selling their pigeonpea there.

Mutie discovered a reliable and profitable market in Mombasa – a coastal town 350 km away where there are many hotels and restaurants that service the port. She sells the bulk of her green pigeonpea pods there for KSh 30/kg.

During the pigeonpea harvest season, Mutie spends her mornings packing the pigeonpea into

bags. At around 5:30 in the evening she meets the lorries or matatus (passenger vehicles) that are on their way to Mombasa. She loads her pigeonpea sacks on them and by 4:00 am the pigeonpea reaches the coastal town. Mutie's business partner meets the lorries to collect the bags and then he in turn sells the green pigeonpea to various restaurants and also at Kongoweya market in Mombasa.

Mutie says she and the trader agree beforehand on the price that he will pay her. If she finds it acceptable she goes ahead with the sales. The pair also share the cost of the lorries that transport the bags to Mombasa with Mutie paying KSh 60 per 100 kg bag and the trader paying KSh 40.

Mutie is not just an example of what market linkages can do but also what modern technology can do. Mutie's cell phone (also bought with money earned from pigeonpea sales) has become crucial to her business. When she loads the bags of pigeonpea onto the lorry she phones the trader to let him know that they are on their way.

By mid-morning the next day, Mutie gets a message on her cell phone to let her know that her M-Pesa account has been credited with her money. M-Pesa, a banking service offered by the Kenyan network provider Safaricom, allows users to establish accounts and send money to each other through cell phones. Mutie can access her money in various ways through her phone or if she needs to withdraw cash she can go to her nearest Pesa-Point, which works like an ATM, and withdraw her earnings.

In 2009/2010, Priscilla sold a total of 10 × 100 kg bags of pigeonpea at KSh 40 per kg locally. Last season alone she made KSh 80,000 (USD1000) from her pigeonpea sales. The price varied from the start of the season at around KSh 80 to a minimum of around KSh 40 towards the end of the season when the competition is greater.

The material that Mutie received from ICRISAT has the advantage of maturing early. The pigeonpea can be harvested as early as February. This means that Mutie is able to sell her pigeonpea when the commodity is scarce in the markets, giving her the opportunity to cash in on the few weeks when the price per kg can be as high as KSh 80. She sells her produce from Feb to June/July, stopping when the pigeonpea markets are flooded and the price drops down to KSh 50.

Mutie says that the challenges that she faces now are the problem of pests and the price of labor which has escalated from KSh 2–3 to KSh 10/kg. But she adds this isn't anything that she can't handle.

The money that Mutie has made over the last few years has been wisely invested. Besides the dairy business that she started she helped her son build his house and she made sure that he has electricity. She also dug a well to secure a supply of water and helps pay school fees for her grandchildren. "I feel stable now," she says.



*A few hours shelling pigeonpea means extra money in the marketplace.*

## Intercropping in Malawi



Malawian farmers traditionally grow pigeonpea in between rows of maize. There may be a few trade-offs in terms of competition for resources, but it can also be a very smart strategy as farmers in Malawi found out recently.



“Mwanza District is a disaster area,” Oswin Madzonga, Scientific Officer at ICRISAT-Lilongwe, says. Farmers here have started chopping down trees to make charcoal in an attempt to earn some much-needed cash. Ethel Smart of Epesi village lost all of her maize. She also lost a lot of her store of maize seed because when the rains failed, Smart, like others in her village, sowed more maize seed in the hopes that the rains would be on their way. Some even sowed their fields for the third time. And still the skies remained empty. “I won’t be able to sell my pigeonpea. I’ve not got enough. I will use it as relish,” Smart says. “This is the only available relish this year.”



Mrs. Mary Musa's half-hectare plot in Namanla village is right across from a school. The children gather to hear her tell her story of the dry spell that hit Chiradzulu District from the middle of January to the middle of February. Musa's maize was tasseling. The lack of moisture at such a critical growth stage resulted in the total failure of her maize crop.

The good news for Musa is that her pigeonpea crop is doing well. The pigeonpea hadn't yet started to flower and when the rains arrived after a month break, the pigeonpea recovered. In fact, it is doing better than just recovering. "There's a better canopy than last year," Musa says.

"When the maize failed, the pigeonpea became the sole crop," Madzonga explains. "The pigeonpea will now do very well."

Musa expects to get a 100 kg of pigeonpea from her plot. She will sell the pigeonpea to buy maize meal, an essential component of her daily diet. Maize costs around MK 40–50 per kg (USD1 = MK 170). The price of pigeonpea is anywhere between MK 50 at harvest and MK 100 in September when supplies are low. There's no doubt about the market," Musa says. "The traders will come from town."



## Promoting purity: Genetic fingerprinting of groundnut

### What you see may not be what you get

You are shopping for groceries and stumble across a display with those little packets of seeds. It is spring. Flowers, you think, good idea. You decide to buy carnations. Deep red ones. You picture them growing through the summer, bright red bursts tastefully scattered throughout your garden. You go home and sow the seeds. You water them every day and wait. And a few weeks later you spot the beginnings of new leaves in the earth and your carnations grow and finally make buds. Imagine then your disappointment when the flowers finally bloom and the carnations are not the deep red promised on the packet but white.

It isn't the end of the world if the flowers in your garden are white instead of red. But now imagine this same situation for a smallholder farmer in a village in Malawi. She earns MK 120,000 or approximately USD800 on average per season

from her farm of 1–2 hectares. She has got anywhere from three to seven children to feed, clothe and educate. In the beginning of the season she spent MK 30,400 (USD200) on 100 kg of certified groundnut seed for her 1 hectare field. It takes 90–100 days from sowing to harvest, three months from investment to profit.

Halfway through the season the leaves on her groundnut plants show yellow mottling and begin to brown around the edges. She pulls a few out to find that there are no pods filling underground. Her entire harvest, in other words her entire income, for that season is destroyed. This is because the seed she sowed was not of the variety Baka, a drought-tolerant, rosette-resistant variety as promised on the packet. Instead, it was seed of a similar variety called JL-24, a variety that is susceptible to rosette. Imagine the consequences for this farmer and her family.





*Rosette is the most destructive disease of groundnut in Africa. The virus damages leaves (left) and severely reduces the size and number of pods an infected plant is able to produce (right).*

### The Seed Services Unit

It is the job of Malawi's Seed Services Unit (SSU) to ensure that what a farmer is promised when he/she buys certified seed is what is delivered.

"We are there to ensure that there is no fraud and that the seed is of the highest quality," says Grace Kaudzu, Seed Technologist at SSU. This means that SSU inspectors will visit the fields of every registered seed producer a minimum of four times during the growing season. "We need to follow up in order to maintain quality in the field," Kaudzu says.

The first field inspection is done before planting. According to Kaudzu, SSU "must know the history of the land." In order to ensure that there is no genetic mixing, seed producers cannot produce seed of a particular variety if they have grown that variety as grain in the previous season. There is a one year ban to make sure that the field is clean.

The second visit is done at the vegetative stage and the SSU inspectors check the characteristics of the crop such as leaf expression against what the breeders have said is typical for that particular variety. The third visit is at the flowering stage and the fourth visit is after flowering.

SSU inspectors then collect samples of seeds from the fields that they monitor and submit them to

their laboratory in Lilongwe where physical purity tests (tests to make sure there is nothing else mixed in) as well as germination tests are done.

Conducting these tests takes time. "For groundnut, it can take three weeks or so before the results can be given," Kaudzu says. It takes seven days for groundnut seeds to germinate.

Conducting the tests also takes manpower, a resource that is limiting at SSU. There used to be only one laboratory for the whole country, but the Malawian government has recently opened three satellite laboratories. There are currently about seven field inspectors and four analysts for the whole country.

But even with the recent increase in SSU staff, there has also been a recent spike in the number of registered seed producers as a direct result of Malawi's subsidy program. In an attempt to increase the availability of certified seed and thereby increase yields, the Malawian government started a subsidy system where farmers would be given vouchers which they could redeem for certified seed. For the system to work, there needs to be enough certified seed available in the country. And this requires many more seed producers.

Producing seed is a good business. Depending on the crop and variety, the price for seed can be

almost double or three times the price of grain. Groundnut seed costs MK 120/kg. Groundnut grain costs MK 80/kg. And so farmers are willing to go the extra mile, to pay for registration and undergo inspections in exchange for a better price when they sell their seed. However, this better price means that some farmers try to pass off grain as seed by mixing it in with seed, making the work done at SSU even more important.

### Moving from the field to the lab

A fingerprint has long been used as a means of identification. Since no two are exactly alike, a fingerprint can be used to tell one person apart from another. The same principle holds true for different varieties of any given crop. The genetic structure of each variety of groundnut is different enough from each other and can therefore be used as a fingerprint against which other samples can be compared.

“Seeds of different varieties can all look similar. It isn’t possible to tell them apart based on what they look like,” says Dr. Santie de Villiers, Biotechnologist at ICRISAT-Nairobi. “But with fingerprinting it is possible to answer two very important questions of any sample: What variety is it? And is it all the same?”

In other words, de Villiers’ DNA-level tests can determine the identity and purity of any given sample of seed – the same twin questions that the SSU attempts to answer every growing season for its registered seed growers.

The beauty of judging identity and purity in this manner is that it transfers a lot of the SSU’s work from the field to the laboratory. This means that answers can be reached in a matter of days instead of weeks. A seed producer will be able to sell his certified seed in a few days after harvest rather than having to wait close to a month before getting money for his/her product.

It can also save money as the SSU inspectors can reduce the number of visits to each field to one per season – to collect samples for DNA fingerprinting – instead of four. They can also

collect samples from any part of the plant at any time of growth – in other words, they can, for example, collect leaves to be tested instead of waiting until the plants produce pods. Since the tests are based on DNA, they are more accurate than asking inspectors to compare leaf characteristics or seed size and color, which can be rather subjective. However, the physical characteristics remain essential and will still be used to support/confirm the DNA fingerprint results.

### Finding a fingerprint

Before this system can work at that level, de Villiers must first determine the fingerprints for each variety. There are six officially released groundnut varieties in Malawi. Because each fingerprint is a unique definition of a specific groundnut variety, de Villiers must ensure that she checks her fingerprints against all of the genetic variety that is available in Malawi. She does this by comparing the six varieties against each other and also against all the known genetic diversity available in Malawi’s farmer fields and genebanks.

De Villiers also uses known and published molecular markers to establish the fingerprints. “A molecular marker is basically like a milestone on a road,” de Villiers says. It is a known sequence of base pairs that indicates a certain place on the DNA that tends to differ amongst different varieties, allowing scientists to tell them apart.

The Generation Challenge Program has already published 21 markers for groundnut. De Villiers used these markers to run her tests on 19 varieties of groundnut representing all the cultivated groundnuts available in Malawi. Her results show that each of the six released improved groundnut varieties can be fingerprinted or identified using a minimum of two to four markers instead of running the test against all 20 available markers.

Now that the six fingerprints have been established, de Villiers is able to determine if an unknown sample of seed is pure or a mixture of varieties. Her research will allow monitoring of



*Irish Ambassador to Malawi, H.E. Liam McGabhan, launches the MASA brand in Lilongwe. Farmers will now be able to buy high-quality certified seed packaged in bags sporting the MASA logo.*

identity preservation and seed purity and, when adopted fully by the SSU, will form part of the seed certification process in Malawi. The study that helped to identify the unique fingerprints will also be used to create a map of the genetic diversity of groundnut in Malawi.

An interesting offshoot of this research is that it can be used to track dissemination and/or adoption of new varieties. An improved medium-duration pigeonpea variety (ICEAP 00557) has recently been released in Malawi. Seed of this variety will be making its way to farmers through Malawi's subsidy program and also through the work of NGOs. De Villiers has already started working on determining the fingerprints of five officially released improved varieties of pigeonpea. The hope is that the new medium-duration varieties will be adopted by farmers in central and northern Malawi, areas that traditionally do not grow pigeonpea. In the future,

samples collected from farmers' fields in these regions can be tested to determine how far and wide a given variety has spread, increasing our understanding of how new varieties are adopted throughout a country.

De Villiers' work on genetic fingerprinting of groundnut and pigeonpea is part of a larger project funded by Irish Aid that aims to promote smallholder farmer's access to certified seed that is guaranteed to be pure and healthy. The project is supporting the Malawi Seed Alliance (MASA) that encourages smallholder farmers to use certified seed to secure higher yields. High-quality certified seed will be sold to farmers under the MASA brand.

The key to success for the MASA brand is to establish and maintain high standards of quality, thereby promoting the grower's trust. "The grower will have the confidence that this is the variety being sown and that it is of high quality. It will set a gold standard," de Villiers says.

## How genetic fingerprinting works

We've all watched episodes of CSI where forensic scientists compare samples of DNA found at the crime scene with those of a suspect to establish whether or not a suspect is involved. The method and the rationale used to determine whether or not a sample of seed is of a certain variety is not very different.

Most genetic material of a certain species is similar to each other. For example, 99% of the DNA in humans is identical between individuals. Forensic scientists look for the difference in 1% of our DNA to establish identity. It is no different for groundnuts. Despite the overwhelming similarities, there is enough difference in the sequence of the four base pairs, or building blocks, of DNA to be able to tell groundnut varieties apart from each other.



The first step in the process is extracting the DNA. After allowing the samples of seed to germinate, Laboratory Technician, Vincent Njunge, cuts up leaf samples and follows a series of steps that will mash up the leaf tissue in order to break up the plant cells, releasing the DNA from within.



The solution of DNA is protected using an extraction buffer and the sample is cleaned to ensure that it is as pure as possible by using a centrifuge that lets the cell debris settle at the bottom and the DNA to float on top. After a few more purification steps, the resultant DNA pellet at the bottom of the tube is ready for use.



The DNA is redissolved and analyzed on an agarose gel to check the amount and quality. Subsequently, very specific short pieces are amplified by polymerase chain reaction (PCR) at specific points, or markers, on the DNA roadmap. Different varieties will yield different sized fragments. These pieces of DNA can then be separated according to their size.

In the past, this separation was done using a gel. The smallest pieces of DNA travel the furthest through the gel and are closest to the bottom of the gel tray. The larger pieces remain closer to the top. This type of separation would provide the fingerprint against which subsequent samples can be tested.



The gel method yields results as shown above where the known fingerprints are on the left (numbers 1 to 6). The unknown samples can then be compared against these known fingerprints – a matter of matching the bars. In this example, the column with the arrow is clearly the same as known variety no. 3, which is the fingerprint for Baka.

Today scientists use a DNA sequencer to separate the PCR fragments instead of the gels to obtain much more accurate results. Laboratory Technician, Geoffrey Mugambi, analyzes the results from the DNA sequencer which shows the fingerprint as a series of graphs with peaks that can be translated in a similar manner as the gels to determine the identity of the sample.

## Re-stocking Zimbabwe's shelves with seed



### Seed shortage in Zimbabwe

For a rural household struggling to balance on that thin edge between survival and poverty, between a nutritious diet and hunger, seed can tip the scale. The quantity of seed available, the quality, and availability of seed of a variety of crops are all factors that contribute to successful farming.

Given that Zimbabwe's shelves have until recently been bare of all staples including bread, milk, sugar, flour, it is no surprise that the country has also experience a shortage of seed. NGOs have stepped in, handing out tons of seed to thousands of struggling farmers over the last 5–10 years.

This stop-gap solution has generated its own problems. For example, some of the distributed seed was of unknown, non-adapted varieties of sorghum and not 'Macia' – a sorghum variety well

known to Zimbabwe's farmers. Unfortunately, these non-adapted varieties did not even flower in Zimbabwe's climate. "Instead of distributing sorghum seed, they ended up distributing hunger," Sakile Kudita, Scientific Officer at ICRISAT-Bulawayo says.

The solution to these sorts of problems is obviously a functional seed industry where the private sector produces and sells high-quality seed of improved varieties to farmers around the country. One of the first steps to that end lies in the availability of foundation seed.

### Foundation seed

During harvest, farmers usually engage in some sort of selection process based on shape, weight, color, etc. and save some of their grain to use as seed in subsequent seasons. Over time there is an erosion of yield if no new material is added to the system.

Foundation seed, the seed originating from breeder's seed, is multiplied and eventually sold as certified seed to farmers. ICRISAT-Bulawayo, with funding from USAID/OFDA through FAO, has been working on producing foundation seed of four crops – two legumes (groundnut and cowpea) and two cereals (sorghum and pearl millet).

“By producing this foundation seed, we believe that we will advance the genetic purity of seeds substantially. We will arrest the loss of vigor over time,” Dr. Isaac Minde, Economist at ICRISAT-Bulawayo, says. “It is not necessarily the role of the research centers to produce foundation seed. Our mandate usually lies closer to making new varieties available. But in Zimbabwe we believe that some kind of rescue activity is needed”. If we

don't arrest this situation at this stage, we may not even have any foundation seed left.”

This was almost the case for cowpea when the project started two years ago. The Crop Breeding Institute (CBI), part of the Government's Research and Specialist Services with a mandate to produce foundation seed of varieties released in Zimbabwe and a partner in this project, was only able to provide 5 kg of seed of each of the three varieties of cowpea. “That was all they had available at that point in time,” Kudita says. “We have built from those 15 kg to close to 2 tons of cowpea foundation seed.”

In this second season of seed production (2009/2010), ICRISAT-Bulawayo has produced 10100 kg of sorghum seed, 9418 kg of pearl millet seed, and 4000 kg of cowpea seed.

*Quantities of foundation seed of cowpea varieties, CBC1, CBC2, and CBC3, suited to the drought-prone agro-ecology of Zimbabwe, were especially low. Today, close to two tons of foundation seed are available.*



### Choice of crops

The choice of working on sorghum, pearl millet, cowpea and groundnut was purposeful. They are well suited for the low moisture regimes prevalent in the semi-arid tropics. They are also nutritionally important as sources of protein and energy.

“When you look at Zimbabwe, the problems of inadequate nutrition and hunger are more strongly associated with the semi-arid areas, Natural Regions IV and V,” Minde says. “The higher rainfall areas of Natural Regions I, II and III carry a more diverse set of crops and malnutrition and hunger in those areas are less common.”

Another reason that these four crops were chosen is that they are often ignored by the private sector. Since farmers tend to save their own seed rather than buy seed of these open pollinated varieties

every season, seed companies are reluctant to work with these crops as it is considered a high-risk activity.

“What is needed in Zimbabwe is a culture of buying certified seed,” Minde says. “This culture used to exist in the country. Seed used to be a priority for farmers and they were willing to augment what they saved with store-bought seed.”

Minde believes that this culture can be resurrected and the resulting demand for certified seed will benefit the private sector. Though the project is still a few steps away from measuring impact in the farmers’ fields, already there are the first signs of success with seed companies buying ICRISAT-produced foundation seed to multiply and sell. It may be that the days of “distributing hunger” in Zimbabwe are over.



*Nkazimulo Ngwenya, ICRISAT-Bulawayo, and Savemore Ngirazi, CBI Groundnut Breeder (left), monitor the progress of groundnut foundation seed production at ICRISAT-Bulawayo.*



*In the 2009/10 season, ICRISAT-Bulawayo produced more than one ton of foundation seed of four varieties of sorghum. Isaac Minde, Economist, and Sakile Kudita, Scientific Officer at ICRISAT-Bulawayo, check the sorghum fields after heavy rains in early April.*





### From handouts to vouchers: Increasing the efficiency of seed relief programs

In order to sustain a functional seed industry Zimbabwe's smallholder farmers will need to make the shift from receiving relief seed to buying their own seed from local agro-dealers. NGOs and development investors are looking at different models to find a method that will ease farmers through this transition.

One method currently being tested by the World Bank through GRM International and ICRISAT is the use of vouchers that farmers can exchange at their local retail outlet for seed. The hope is that this will get farmers back into their local retail outlets that are well-stocked with different varieties of seed of various crops. Farmers will not just get back into the habit of buying seed but they may also start to experiment with different crops or fertilizer options.

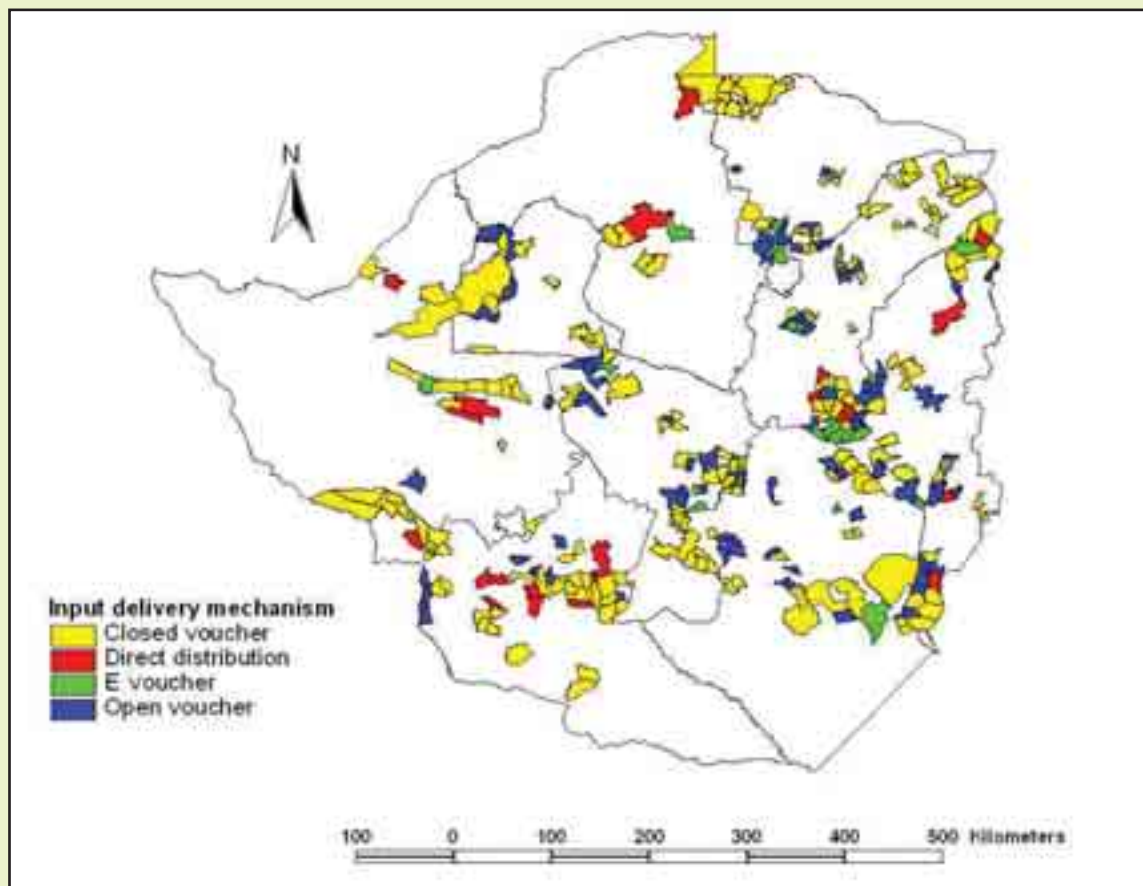
The decade of relief interventions has in effect meant that seed companies stopped supplying rural outlets since they knew that farmers would be receiving free seed from NGOs. "This approach has the benefit of re-engaging agro-dealers and wholesalers in the market," says Kizito Mazvimavi, Economist at ICRISAT-Bulawayo. "The vouchers work as a cash flow into a cash-starved system to get it started."

During the 2009/10 season, NGOs distributed maize seed to 300,000 farmers through the World Bank-funded Zimbabwe Emergency Agricultural Input Program (ZEAIP). Each farmer received a 10 kg seed pack through vouchers redeemed at selected rural agro-dealers. Mazvimavi's evaluations of this effort show that 90% of this seed was sown and contributed to 41% of the maize planted by these recipients.

In the following seasons, the relief efforts will get even more sophisticated and as a result even more efficient. Mazvimavi and his team have developed a map of Zimbabwe that shows which of four options will work best in the targeted areas based on various market criteria. The four options range from direct distribution for remote areas with limited road access and no retail outlets, a closed voucher that is redeemable for only a specific product such as a 10 kg bag of maize seed, and an open voucher that is redeemable for a certain value and allows farmers a choice in what they buy. The fourth option being explored is an electronic voucher for areas with reliable cell phone network coverage.



*A local agro-dealer in Chivi district, Zimbabwe, hands over groundnut seed to farmers in exchange for vouchers.*



*Maps such as this one showing which input delivery mechanism has the greatest chance of success in the various districts of Zimbabwe can be highly useful for NGOs as they plan the next season's relief programs.*



## From forest to fields: Assessing land cover change

### The importance of land

The 530,000 hectares that comprise Nkayi district in southern Zimbabwe is a combination of crop fields, natural forests, and rangelands. This land must support all the different forms of life that depend on it – crops, wild animals, cattle, and, of course, all the people, most of whom farm for a living. The ability of Nkayi’s natural resources to support all these demands and provide ecosystem goods and services alters over time as people change the landscape to feed their needs.

How have natural resources in Nkayi district changed in the last two decades? Are we expecting more ecosystem goods and services than Nkayi can provide? What are the trends in land use and is the situation sustainable? These are some of the questions that ICRISAT-Bulawayo’s crop-livestock team attempted to answer.

“We have created a historical environmental profile of Nkayi district starting from 1990 until

the present,” says Albert Chirima, Scientific Officer at ICRISAT-Bulawayo. “This profile describes the trends in land use and the requirements of the land users over time.”



*Newly cleared fields like this one in Nkayi is one of the main ways that land cover has changed in the district over the past two decades.*



*GPS in hand, Albert Chirima cross-checks remotely sensed data on land use and land use change. Verifying these changes on the ground provides important opportunities for scientists to interact with the people of the semi-arid tropics.*

Chirima estimates land degradation by determining changes in land cover in Nkayi over time. He does this using LANDSAT images taken on cloudless days in April 1990, June 2000, and May 2009, just after the rainy season when leaf growth is at its peak. April–May is also the time of the year when the crops have been harvested, making the fields easy to distinguish during image analysis.

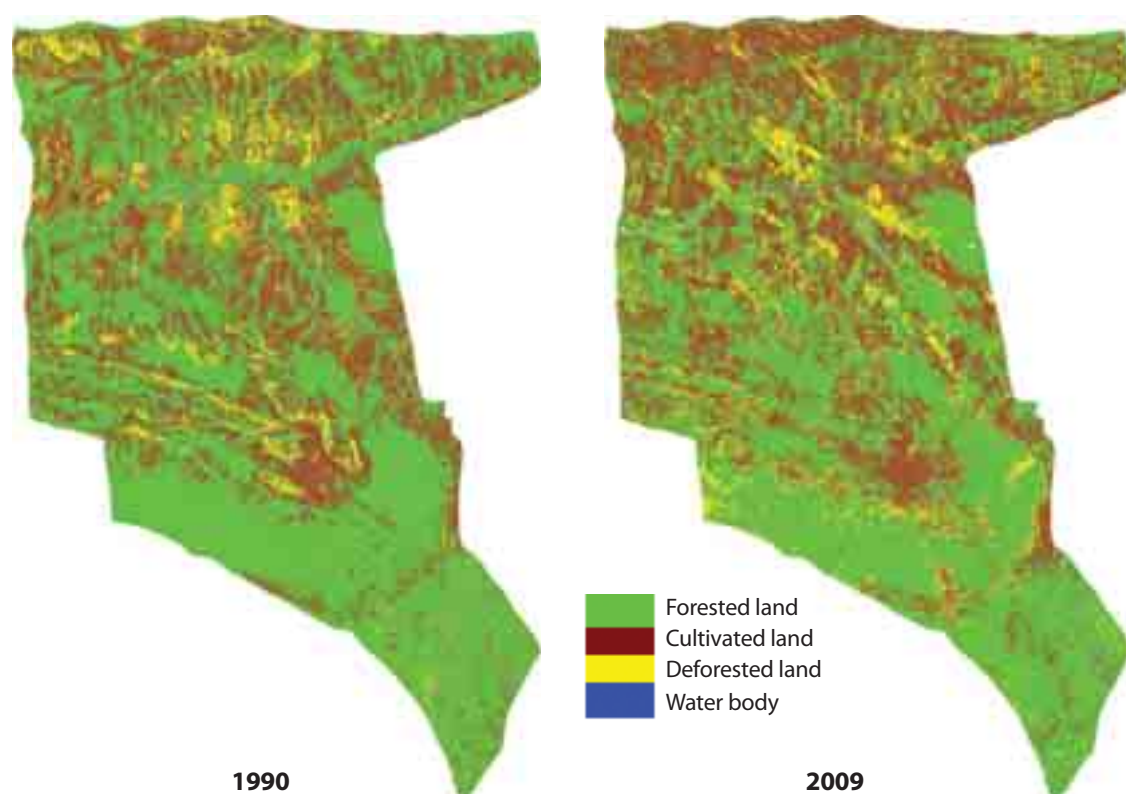
Although the resolution of LANDSAT and other remotely sensed images have greatly improved in recent years, ground truthing is essential to ensure that this work is realistic and true to life. Much ground work in Nkayi was conducted to geo-reference images from different years and to ensure the accuracy of the defined landscape features (in other words, to make sure that forest is forest and fields are fields). Interactions with local people confirmed certain changes

and provided evidence for others. Structured discussions with locals also verified and explained many of the observed temporal changes.

### **Nkayi then and Nkayi now**

Chirima's work shows there has been significant changes to land cover in Nkayi in the last two decades. One of the main changes has been a decrease in forested areas by 14%. Crop lands increased in the same time period by 13%.

The main reasons for the conversion of the forest land into fields is two fold. Nkayi is one of the most densely populated districts in Zimbabwe with more than 25 people/km<sup>2</sup>. "The actual number of people in Nkayi has not changed," Chirima says. "But the number of households has increased and these new households clear land to make new fields."



*Two decades of change – a 13% increase in crop lands is captured in the growing area of brown on the map of Nkayi in 2009.*

In addition, the soils in Nkayi are not very fertile. Resource-constrained farmers are not necessarily able to improve soil fertility or use fertilizers to increase their yields. The easiest option for many of them is to simply leave their land fallow when yields begin to diminish and clear out a new field.

The natural regeneration process in fallow lands takes a long time. "This fallow land is depleted of its nutrients," Chirima says. "Families let their cattle graze in these fields but the nutritional quality of this feed is rather poor."

Studies show that Nkayi district today supports the same number of cattle as it did twenty years ago. But the difference is that the grazing land available for the cattle has decreased significantly, resulting in greater pressure on the land and degradation, i.e. changes in plant species composition in rangelands, including bush encroachment, and soil erosion in places where animals congregate or along footpaths towards water points.

"Crop residues do not compensate for the loss of rangeland," says Dr. André van Rooyen, Scientist at ICRISAT-Bulawayo. "The expanding crop fields must compensate for the loss of the rangelands by producing equal or more biomass for feed as the rangelands used to."

Some potential solutions to ensure that the expanding fields compensate for the loss of the rangelands is to explore solutions such as introducing dual-purpose sorghum cultivars and intercropping conventional crops with fodder crops. "As a crops research institute, we've got to ensure that we improve production per unit area, including livestock production. In other words, the solution to this situation lies in learning how to use our crops more effectively both as food and feed. This has a direct bearing on our mandate to decrease poverty and hunger," says van Rooyen.



### Land use in Ethiopia's eastern highlands

A look at the landscape in the eastern highlands of Ethiopia shows mostly fields. There is almost no natural rangeland left. Ethiopia is already where Nkayi in Zimbabwe is heading.

"Ethiopia has seen a shift from pastoral to a more sedentary agricultural system," says Suraj Pandey, Associate Professional Officer at ICRISAT-Bulawayo. "This has been the primary driver of Land cover change." Human numbers and policy changes have resulted in increased sedentirisation

of the human population. This has led to an increased amount of land devoted to crops, leaving less land available for livestock. Ethiopia's livestock numbers are now limited by the amount and quality of crop residues produced.

The crop-livestock team from Zimbabwe recently visited Ethiopia in an effort to verify remote sensing/GIS work done with ILRI/IWMI partners. This work clearly illustrates the pathway from extensive to intensive small-scale crop-livestock systems. Income here is generated primarily from livestock. As land becomes more scarce for livestock, small-scale farmers find themselves in a serious predicament as feed resources limit their ability to generate an income.



*ICRISAT can play a critical role in paving pathways out of poverty by ensuring sufficient feed is produced in these areas.*



# Appendixes





## Publications List 2009

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Note:

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# About ICRISAT



The International Crops Research Institute for the Semi-Arid-Tropics (ICRISAT) is a non-profit, non-political organization that conducts agricultural research for development in Asia and sub-Saharan Africa with a wide array of partners throughout the world. Covering 6.5 million square kilometers of land in 55 countries, the semi-arid tropics have over 2 billion people, and 644 million of these are the poorest of the poor. ICRISAT and its partners help empower these poor people to overcome poverty, hunger and a degraded environment through better agriculture.

ICRISAT is headquartered in Hyderabad, Andhra Pradesh, India, with two regional hubs and four country offices in sub-Saharan Africa. It belongs to the Consortium of Centers supported by the Consultative Group on International Agricultural Research (CGIAR).

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