ICRISAT
Eastern and Southern Africa
2008 Highlights

ICRISAT
Science with a human face

International Crops Research Institute
for the Semi-Arid Tropics

Citation:

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Eastern and Southern Africa. 2009. 2008 Highlights. PO Box 39063, Nairobi, Kenya: ICRISAT. 44 pp.

An ICRISAT semi-formal publication issued for limited distribution without formal review.

Writing and editing: Swathi Sridharan

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

Cover photo: Pigeonpea in bloom. The crop offers farmers in eastern and southern Africa multiple benefits – a protein-rich seed, fuel, fodder, and fencing material. It also improves soil fertility and provides erosion control.

ICRISAT
Eastern and Southern Africa

2008 Highlights

ICRISAT
Science with a human face
International Crops Research Institute for the Semi-Arid Tropics

ICRISAT–Nairobi
Regional Hub – Eastern and Southern Africa
PO Box 39063, Nairobi 00623, Kenya
2009

Citation:

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Eastern and Southern Africa. 2009. 2008 Highlights. PO Box 39063, Nairobi, Kenya: ICRISAT. 44 pp.

An ICRISAT semi-formal publication issued for limited distribution without formal review.

Writing and editing: Swathi Sridharan

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

Cover photo: Pigeonpea in bloom. The crop offers farmers in eastern and southern Africa multiple benefits – a protein-rich seed, fuel, fodder, and fencing material. It also improves soil fertility and provides erosion control.

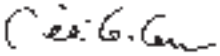
Contents

Preface

Agriculture – the backbone of most African economies – provides 60% of all employment and supports 70–80% of the populations in Eastern and Southern Africa (ESA). ICRISAT-ESA's research strategy has three regional programs on genetic resources enhancement and management; agricultural diversification and agro-ecosystem sustainability; and improving markets, policies and institutions. These programs are designed to address the various challenges in the region such as low productivity, poor market access, weak national capacities, and a lack of enabling policies and institutions.

The six stories in this 2008 Annual Report have their roots in at least one of the three regional programs. The new medium-duration varieties of pigeonpea in Malawi demonstrate the need for breeding solutions that take into account cultural practices as well as agro-ecological variations within a country and dryland areas of ESA. Understanding the passage of chickpea from the farmers' fields to the consumer overseas provides new insight into the various links and relationships that constitute markets in Ethiopia. The influence of government policies on the seed sector is revealed in a story on Malawi's subsidy program. New technologies must first be tested and the associated risk evaluated before they are released. ICRISAT's work on assessing geneflow in sorghum contributes to a global initiative to boost nutritional security through biofortification. The development and adoption of new technologies require new partnerships and new approaches. The last two stories describe ICRISAT's changing relationship with the national meteorological services as well as a new approach to promote technology adoption in the region.

ICRISAT-ESA's regional strategy is designed to deliver impacts through the application of science and technology in a development context. We hope these stories provide a greater understanding of the Institute's work that is contributing to achieving poverty-focused solutions for smallholder farmers in eastern and southern Africa.



William D Dar

Director General

Said Silim

Regional Director for
Eastern and Southern Africa

Highlights

Medium-Duration Pigeonpea – a Reality for Malawi

"There's too much crying in it," says Petro Sitima Nkhoma, describing a locally grown variety of pigeonpea called Mthwajuni. "These others make better flowers, better pods. They don't struggle!"

Besides Mthwajuni, Nkhoma is growing five other medium-duration pigeonpea varieties on his three-hectare farm in Yesaya Juba village, Mzimba district. Farmers in Malawi usually grow long-duration pigeonpea, mainly local varieties and others such as ICEAP 00040 that have been released by the government and take 9–10 months to harvest. Medium-duration pigeonpea will be ready for the market in only 6–7 months.

There are no officially released varieties of medium-duration pigeonpea in Malawi yet. But with the help of farmers such as Nkhoma who cooperate with ICRISAT breeders and agronomists to assess the performance of these potentials for release, Malawian farmers may soon be able to grow pigeonpea varieties that *don't struggle*.

The medium-duration advantage

There are several benefits to having a crop mature quickly. For example, long-duration pigeonpea depends on the Chiperoni rains, showers that fall in the dry season from May to July. If the rains do not fall, pigeonpea yields decline or fail altogether. "Medium-duration pigeonpea frees farmers from depending on the unreliable Chiperoni rains," says Dr Ganga Rao, breeder at ICRISAT-Nairobi.

A shorter stint in the field can also mean less time for diseases to take hold. "Fusarium wilt is a major problem for pigeonpea," says Ganga Rao. "But it takes some time to establish itself and spread. With the shorter time it takes for medium-duration pigeonpea to mature, less damage is done."

Apart from reducing the risk of disease, the risk of wild fire and damage to the crop is also reduced. It also means that farmers are now able to prepare the fields for subsequent seasons sooner, providing additional time in a system where labor is often limited.

But the biggest advantage, especially for farmers in the south, stems from the intersection of culture and agriculture. Pigeonpea is a crop that is rarely grown on its own. It is most often seen intercropped, emerging from between rows of maize and even tobacco or cotton. Once the maize is harvested, farmers let their livestock roam the fields unsupervised as they have done for many generations. With predictable certainty the goats head straight for the only crop that is still green – the pigeonpea. Medium-duration pigeonpea is harvested immediately after maize, which means that when the ravenous goats are released the pigeonpea is safe.

Why not simply build a fence around the field to keep goats and cattle away? The answer to that is also rooted in culture and tradition. Land in Malawi is not owned by the farmers who cultivate it. The land belongs to the government and the

Leaves, pods, seeds – it does not really matter. Every part of the pigeonpea plant is delicious fodder for Malawi's far-ranging livestock. A herd of goats can damage a farmer's harvest in minutes.

local chief allocates parcels of land to families at his discretion. Without secure tenure, farmers do not have the incentive to fence off fields.

The approach

Pigeonpea is very familiar to farmers in the southern districts of Malawi. The crop is harvested either as green pods or as grain and routinely sold in local markets. "Farmers in southern Malawi are also familiar with the idea of a medium-duration pigeonpea thanks to Mthwajuni," says Handsome Chipeta, Scientific Officer at ICRISAT-Lilongwe. "Mthwajuni literally means *runs from the cold weather in June*."

The fact that farmers are already exposed to the concept of a medium-duration variety should prove to be of immense value in increasing the adoption of the soon-to-be released varieties.

"We have a two-pronged approach with regards to pigeonpea in Malawi," Ganga Rao says. "We believe that farmers in southern Malawi will make the switch to medium-duration pigeonpea relatively quickly. But we would also like farmers in north and central Malawi to start to grow medium-duration pigeonpea." The approach used by ICRISAT and the extension department in Malawi will differ based on the regions in question. Those in the north and central regions of the country will have to be introduced to the crop and shown the best agronomic practices as many have not grown it before and remain unaware of its market potential. For example, in central Malawi, the medium-duration pigeonpea will have to be intercropped with maize and groundnut so that both crops will be harvested at roughly the same time and the pigeonpea will contribute to the fertility of the soil.

Handsome Chipeta examines the performance of ICEAP 01167/11 planted next to the local variety Mthwajuni. Years of working with pigeonpea allow him to quickly evaluate a variety's performance in the field and choose the best option for the different regions of the country.

A farmer marking her choice at the farmer participatory varietal selection in Mbeere district of eastern Kenya.

Pigeonpea in Kenya

ICRISAT is also evaluating medium-duration pigeonpea varieties for release in Kenya where pigeonpea is a very important crop. Farmers typically earn Ksh 90 per kilogram of dry pigeonpea. There is also a huge demand for green pigeonpea, which is cooked and eaten in much the same way as peas.

Imminent release

The release of the medium-duration varieties is the culmination of great teamwork. Dr Said Silim, Regional Director for ESA, bred pigeonpea for Nairobi, selected those with potential and sent them to Malawi for evaluation in 2002. Since then through a number of seasons of on-station and subsequently on-farm experiments Silim and now Ganga Rao, with the help of Chipeta, have selected and bred the five pigeonpea varieties that are going through their final stages of testing. The ICRISAT staff worked very closely with local researchers, in particular, Dr Geoffrey Kananji, Legume Breeder, and National Research Coordinator at the Chitedze Agricultural Research Station in Malawi.

"The farmers are just too excited," says Kananji. "They really want the medium-duration pigeonpea. I have to say hold on, we need to follow protocols here." Kananji believes that by the end of 2009 the varieties that farmers have helped to choose and name will be released. "I've worked hand-in-hand with Silim and Ganga Rao," he says. "I will get their final views and then prepare the write-up required by the Technology Release Committee." One of the requirements of release is that the 'start-up material', in this case seed, is available. To fulfill this requirement, Kananji has been busy multiplying seed in various locations around the country.

"All our projections are that the demand for pigeonpea is going to grow," Kananji says. The Malawian government subsidy program added pigeonpea as one of four legumes in 2008. He estimates that they will need approximately 20–30 metric tons of seed to feed into the subsidy program. Pigeonpea is also a favorite crop of His Excellency Bingu wa Mutharika, the President of Malawi. "Bingu loves pigeonpea," Kananji says. "The fact is that he really puts agriculture at heart." The President grows the crop on his farm and opened a processing plant in Blantyre in the first week of May 2009. This attention from the government underscores the importance of pigeonpea to Malawi. The country currently exports pigeonpea to India, Europe, West Indies and Venezuela, earning valuable foreign exchange. Medium-duration varieties would allow Malawi to export its pigeonpea earlier in the year and secure a premium in the global market. As Silim says, "The medium-duration revolution is about to begin."

Farmer's choice

On 9 June 2009, Chipeta speaks to around 20 farmers from Rivirivi Extension Planning Area, who have gathered at Mrs. Fanny Tayali's farm in Khoswe village. Tayali's pigeonpea trials, like all the others, are planted next to the dirt road in the front of her property so that passersby can see what she is growing.

Chipeta tells the farmers of Mrs. Tayali's experiment with medium-duration pigeonpea. He explains the benefits of an early harvest. He also underscores the fact that all parts of this plant can be used: apart from using the grain by a household or selling it off to generate cash, the leaves and pods walls can be composted or fed to livestock, and the dry stems and branches can used as firewood. Chipeta asks the farmers for their opinion – which of the five varieties plus Mthwajuni do they like based on characteristics such as the number and size the pods and the number and color of the seeds within the pods.

The farmers walk around Tayali's crop with papers and pencils. They decide they like ICEAP 00557 the best for its pod size and for the number of pods per plant. They ask Chipeta and Ganga Rao to give them seed of these new varieties soon.

Tayali herself prefers ICEAP 01514/15 the best. But she is quick to add that she really likes them all. When medium-duration pigeonpea varieties are released she says she will definitely grow them. Tayali grows tobacco, cotton and maize on her farm and she intercrops pigeonpea with all three. In other words, she grows pigeonpea all over her farm. Her usual harvest is anywhere between 75 and 100 bags, each of which can hold up to 50 kg.

After harvesting she takes the pigeonpea seeds out of the dried pods and cleans and grades them. By hitching lifts, taking one bag or two

Farmers from the Rivirivi Extension Planning Area wait for the meeting to begin. They will choose the pigeonpea varieties that they like – a message that Chipeta will carry to Malawi's national program.

every week on market day, she transports her harvest to a local market 15 km away in Ntcheu District. Sometimes if she is lucky she can transport the entire harvest in one go and store it at a friend's house. She usually gets Malawian Kwacha (MK) 40 per cup of pigeonpea or somewhere close to MK 160 per kg. "From the money from pigeonpea I buy groceries and I can take care of my children's school fees," Tayali says. She has four children at the local community center day school, which charges MK 2500 or USD 35 per child per term.

Evaluating pigeonpea: Farmers choose the varieties they like best based on the number of seeds per pod, the number of pods per plant as well as the size and color of the seeds.

Mrs. Fanny Tayali, host of the pigeonpea trial in Khoswe village, Malawi.

Three Steps to Better Markets: Improving the Success of Chickpea Farmers in Ethiopia

Don't let them tell you otherwise. Size does matter. Even a few millimeters can make a huge difference in marketing kabuli chickpea. For example, in 2004 the average price in the global markets for a ton of kabuli chickpea with a seed size of 6 mm was USD260. But the price for chickpea that has a seed size of 10 mm was USD650. A three-millimeter difference in seed size can more than double the price.

Clearly there are huge profits to be made. But farmers in Ethiopia are missing out for a variety of reasons. They do not seem to be aware that certain sizes of chickpea mean much higher prices in the export markets. They are growing kabuli varieties that produce seed of an average size of 5–6 mm, instead of new varieties that produce 7–8 mm grain. Even when the farmers and traders are aware of the price benefits from large-seeded varieties, the required seed of improved varieties is yet to be produced in sufficient quantities to meet the growing demand.

A farmer in Ejere district, Ethiopia, holds up his harvest of kabuli chickpea. From here the chickpea will move through many hands until it reaches a final consumer either in Ethiopia or halfway across the world.

Another reason that farmers do not receive better prices for their chickpea is that, most of the time, the way the markets move the commodity from producer to consumer means that they do not get paid higher prices for a better-quality product. This reduces their incentive to grow chickpea of a higher quality or make the switch from the traditional desi chickpea to kabuli.

As a result of these factors, most farmers are not growing kabuli varieties. A huge majority (95%) of farmers are growing only desi chickpea which sells at prices that are 20–30% less than kabuli. "We initially thought that local markets would not differentiate chickpea and prices for kabuli and desi would be similar to each other," says Shiferaw. "But when the export market started to pick up, then we started to see that the prices were very different."

Bekele Shiferaw, economist at ICRISAT-Nairobi, has been studying the chickpea markets in Ethiopia to address precisely these sorts of problems. "Our intention is to characterize the structure and the functioning of markets, including the effect of grain size and other quality parameters. We are looking at opportunities to improve market access and expand demand for chickpea in domestic and international markets to ultimately benefit small-scale farmers," he says.

Three stages to export

Ethiopia is a major player in the African chickpea market, producing about half of the chickpea grown on the continent. Around 200,000 hectares are sown to chickpea every season. A quarter of

the country's total production is exported every year to Bangladesh, India, Pakistan, as well as the United Arab Emirates and other countries in the Middle East. However, the export volume varies from year to year depending on several factors including the price competitiveness relative to other suppliers and production conditions in the main importing countries.

Given the importance of chickpea to Ethiopia, Shiferaw and his team decided to take a closer look at the market requirements and the various players who move the crop from the field to the processors, domestic retail outlets, and the harbors where it is shipped in containers around the world. They used a value chain approach which allowed them to examine the full spectrum of activities and players, their relationships and governance in order to identify major challenges and pressure points.

The value chain analysis allowed Shiferaw to classify the market into three stages. The primary markets are located in villages and involve actors such as farmers, rural assemblers, retailers, and cooperatives. Secondary markets operate at the intermediate level in the supply chain (e.g. district level) and involve wholesalers (and retailers in small towns) who buy from the primary markets and sell to other larger buyers (or consumers). The tertiary markets play out at the urban level in cities such as Addis Ababa and Nazareth. The actors at this stage involve processors, wholesalers, retailers, supermarkets, whole grain exporters, and processed exporters.

For chickpea to reach the export market it has to move from the rural areas to the cities, passing through the hands and trucks of a whole series of buyers and sellers. This chain captures transport costs as well as the transaction costs associated

Chickpea traders in primary and secondary markets clean, sort, and grade the crop – actions that add value and boost the price of the chickpea when they subsequently sell it.

with handling, storage, and value addition, ultimately influencing the price paid by the consumer or expected by the exporters.

Shiferaw and his team interviewed 122 traders to understand the socioeconomic characteristics of the various players and to determine whether these were different across the different market stages. This has helped them map the value chains for chickpea and estimate the marketing costs, margins, and prices received by different actors along the chain.

Who are the traders?

From the perspective of the farmer, the rural assemblers, who buy almost 60% of their crop, are the most important buyers. Wholesalers in the rural towns account for another 19% of the purchases from farmers and 16% can be accounted for by farmer cooperatives.

Irrespective of whether it is the primary, secondary, or tertiary markets, there are certain characteristics that are common to all chickpea traders in Ethiopia. For example, most traders are self-employed and are usually the sole employee of their business. Most of them have access to a telephone, though no access to computers, fax machines, or the internet. Most do not have access to warehouse facilities, though a few in tertiary markets do.

A closer look beyond these basic descriptors to the differences between the traders in each market reveals some interesting results. For example, the levels of education are similar for all three market stages. Close to 10% of the traders are illiterate whereas 20% have completed primary school and 15% middle school. Across markets, around 42% of the traders had finished secondary school. The rest had attended or had finished college/university.

Women workers at this warehouse at the Farmer's Union in Modjo, Ethiopia, clean the chickpea again so that it is of the highest quality demanded by the export markets.

While education may not make such a big difference in marketing, experience does. The years of experience in trading chickpea is directly related to market stage. Traders in primary markets had an average of 5–6 years, traders in secondary markets 7–8 years. Those in tertiary markets had been in the chickpea business for 9–10 years. The level of education generally tends to decline as one moves from the urban markets to the rural primary markets and tends to increase as one moves from the primary and secondary markets to the more knowledge-intensive tertiary markets.

When Shiferaw looked at the way the markets operated, the need for experience made sense. The relationships between chickpea buyers and sellers are not impersonal. "Most trading occurs between sellers and buyers who know each other and have established prior market relationships," says Shiferaw. This means that the traders in the tertiary market have managed to build up a better network of information sources and agreements which makes them more successful and more trusted. Shiferaw says that when institutions are weak to enforce impersonal market contracts and quality grades and standards, personal relationships and networks begin to assume more significance.

More experience in trading also means greater competitiveness when setting prices. Shiferaw found that those with more experience set relatively lower prices for chickpea, demonstrating a better understanding of the marketing channels available to them and the need to be competitive. South Asian markets in particular are currently very sensitive to price rather than quality. There are 23,000 tons of chickpea per container that is shipped to Asia so that means that even a small price difference per ton can induce a buyer into choosing that particular trader's product. Traders with more experience also tend to offer a lower price to buyers of larger volumes.

Quality in the bag

Since chickpea is sold by weight a few stones and soil matter thrown in each bag can result in a significant profit for the dishonest trader. In order to counter this 'moral hazard', each chickpea buyer must provide his/her own bags. The chickpea is then transferred from one bag to another in the presence of the buyer or his agent. "It seems like a waste of time and money and it certainly adds to the costs but in reality it allows for product inspection. It is just one way of dealing with problems that hinder trade," Shiferaw says.

Shiferaw's research revealed that farmers do not receive a better price for a better quality product. In other words, the market, which is the biggest incentive for farmer technology adoption and ensuring flow of quality products, does not pay the farmer more for supplying a quality product. Quality – defined by grain color, size, and the absence of foreign matter and shriveled or broken grain – seems to become important only in secondary and tertiary markets. These traders even clean and sort through the chickpea to separate out grain of a larger size, which is sold for a higher price. It is important to implement grades and standards at the primary markets because this will give farmers the incentive (in the form of better prices) to improve their production and adopt new varieties.

Selling through the right channel

Shiferaw identified nine paths or channels that link the farmer to the final consumer or exporter. In general, the longer the chain, the greater the transaction costs, and the greater the final price of the product (Figure 1). For example, channel 7 (farmer–wholesaler–supermarket) involves five links along the chain where value is added to the chickpea in terms of transport, storage, cleaning, processing, and packaging to deliver the final product to consumers via supermarkets. The price of this chickpea at a supermarket is around ETB679/100 kg. Chickpea sold at a rural retailer (channel 1) however only involves two links and not as much value addition and is priced at only ETB 270/100 kg.

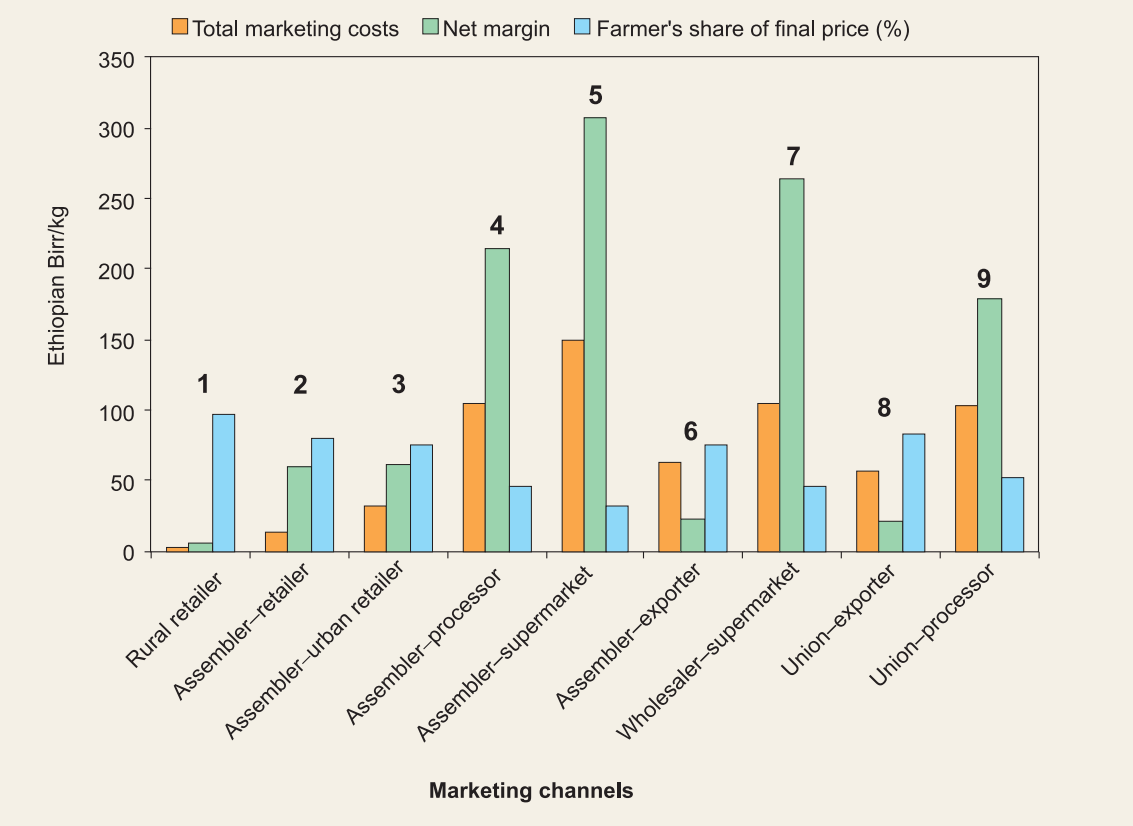


Figure 1. Costs, margins, and farmers' shares in chickpea marketing channels. Channel numbers are shown above the bars. The farmers' price share is expressed as a percentage.

Farmers who sell into channels 7, 8, and 9 earn significantly more money than when they sell their chickpea in the other channels. For example, most rural assemblers offer a price between 260 and 270 ETB/100 kg. However, when selling into channels 7–9 farmers earn between 310 and 370 ETB/100 kg. This is because these channels are more efficient in allowing the terminal benefits to filter back to the farmer.

Institutions such as cooperatives that link the farmers to exporters seem particularly effective in ensuring that the farmers obtain a better price. This is why Shiferaw believes that they will gain importance in Ethiopia where individual small-scale producers cannot achieve market efficiency, especially in areas where the market infrastructure is weak and underdeveloped. The export markets represent an important opportunity for farmers as they are unsaturated; exporters report that they are getting orders that they are unable to fill. By feeding just the right size and type of grain into the export market chain, farmers will ultimately be able to capture a bigger share of the high profits of chickpea.

This however requires greater farmer access to seeds of new varieties and market information to enhance knowledge about prices, quality issues, and seasonal and spatial production conditions. This is important to inform domestic processors and exporters to help them make timely decisions in finalizing trade contracts. Along with greater investment to strengthen market institutions and farmer cooperatives to modernize the marketing systems, there is a need to better understand and diversify trade in global and regional markets. This will prevent unexpected volatility in export demand and prices, which characterize the recent marketing patterns for chickpea and other pulses in Ethiopia.

A Positive Climate for Change: Malawi's Subsidy Program and the Seed Revolving Fund

The potentially devastating impact of climate change has recently grabbed our collective imagination. But, the agricultural sector can be as susceptible to the political climate as any adverse weather conditions.

Malawi's subsidy program is an example of the right political climate. The Starter Pack program, which was introduced in 1998, gave all farmers, free of charge, 10–15 kg of fertilizer and enough improved seed to plant 0.1 hectares. Two years later, the program was converted into the Targeted Input Program (TIP), which reached between 33 and 96% of farming households in Malawi depending on the year. The objective of the program is to increase yields and boost food security of resource-poor farmers by facilitating their access to inputs. The two main components of the program focus on fertilizer and seed. Every year the government distributes separate vouchers for these critical inputs which farmers redeem at local retailers.

In the past, the seed component of the subsidy program focused solely on the crop that is most closely associated with food security in southern Africa – maize. However, in 2008 the government added four important leguminous crops to the package – groundnut, pigeonpea, soybeans and beans. In effect, this created an unprecedented demand for legume seed, one that only ICRISAT-Lilongwe was able to help meet.

Stripping, or separating the pods from the roots, is the first step after harvesting groundnut seed. These women are working in the field of a small-scale seed producer outside of Lilongwe. They will earn around MK 40 per pail of stripped pods.

A captive market

As Secretary of the Seed Traders' Association of Malawi (STAM) and as an owner of a small seed company, Peacock Enterprises Ltd., Felix Jumbe understands seed production and its associated challenges from personal experience. For example, he knows that it is difficult for a small company to take an interest in legume seed because many farmers retain seed rather than buy it each season. The risk of not selling all the seed produced is too high.

This is why Jumbe is pleased with the government's decision to add legumes to the subsidy program. "The vouchers are to us an effective demand," Jumbe says. "The government wanted 600 tons of legume seed in 2008. Of that 300 tons of groundnut seed were needed."

When the government issued tenders, Peacock Enterprises placed its bid to provide groundnut seed. ICRISAT helps small companies like this by selling them groundnut foundation seed of the right varieties through the seed revolving fund as well as providing them with technical assistance on seed production.

*Felix Jumbe of STAM (*right*) compares notes with a commercial seed producer, John Gray (*center*). Tucked in the middle of the bundle of straw is Gray's groundnut seed harvest, waiting to be stripped, shelled, and graded before being sold to ICRISAT.*

"Had it not been for ICRISAT seed there would have been nothing to feed into the subsidy program," Jumbe says. "The name of ICRISAT and legume seed is one."

The subsidy program has in effect taken the first steps towards solving a serious issue: it has made better quality legume seed available to resource-poor farmers. "Now the production of legumes will increase because of the availability of better quality seed," says Moses Siambi, ICRISAT Country Representative for Malawi. Better quality seed also means better quality grain that can attract higher prices in the local and export markets.

Besides an increase in production of these crops, the subsidy program has managed to stimulate the seed sector by allowing small companies such as Jumbe's to take an interest in legume seed. "As a seed company we have a contract with the government that we are authentic seed suppliers," Jumbe says. "There is now competition among seed companies at seed points of sale. The subsidy program has allowed us to sell seed at commercial prices. Seed companies are starting to take an interest in these crops."

The self-sustaining fund

October and November are the busiest months of the year for Teddie Chirwa, Senior Technician at ICRISAT-Lilongwe. He has been responsible for the seed revolving fund since it started in 1999 and knows its workings inside and out.

Once a projection of how much seed is required is made based on previous year's surplus or whether a certain variety is preferred, Chirwa contacts the revolving fund farmers and loans out seed of the varieties required. The farmers then multiply the seed following the standard procedures that ensure high quality. Chirwa visits the farmers during the season to provide any additional training or technical assistance they may require.

"Some of the farmers we work with are very commercialized but we also give a chance to smallholder farmers who can set aside three to five hectares of land for seed production," Chirwa

says. The average yield from the smallholder farmers is between 8 and 12 kg of seed from every kilogram of seed ICRISAT sells them. John Gray, who is a commercial seed producer, harvests 10–15 kg from every kilogram of seed sown.

The farmers strip the groundnuts, shell them, clean and grade the seed before selling it to Chirwa in October. ICRISAT then sells the groundnut seed to buyers such as NGOs or seed companies like Jumbe's, who will ultimately sell to the subsidy program or agro-dealers. "2007's biggest buyer of seed was the Millennium Village Project," Chirwa says. NGOs such as World Vision International, CADECOM, and Concern Worldwide are all buyers of seed. Even other ICRISAT projects that require groundnut seed have to buy from the revolving fund. The money that is made in the process goes towards running the fund for the next year.

A number of costs are factored in before a decision is made on how much ICRISAT will pay to buy back the seed. So far it has always been worth a farmer's effort and applications to join ICRISAT's seed revolving fund keep coming in. One of Chirwa's duties is to screen these. "The whole country knows that ICRISAT does groundnut seed multiplication. We get a lot of applicants," he says.

Ensuring quality

After collecting the seed ICRISAT sends samples to the Seed Services Unit (SSU) for germination and purity tests. Each lot is tested once and a certificate is issued with the germination percentage as well as the purity percentage. The government ultimately certifies that the seed is of the right quality.

It takes the SSU two weeks to complete the tests and farmers have to wait for the results in order to be paid. If the tests are not successful the farmers still owe ICRISAT for the price of the seed that they took out in the first place. However, they can always sell the groundnuts as grain instead of seed. "People have said that the seed that we get from ICRISAT has been the best, has been of very high quality," says Chirwa.

The business angle

"USAID provided USD250,000 in 1999 to fund the sustainable seed production of pigeonpea and groundnut. This then evolved into the seed revolving fund that is still running up to today," says Marcel van den Berg, an ICRISAT business expert who has recently been studying the fund. "It has been a useful and lasting investment of USAID. That USD250,000 is still being used for the last eight years."

Van den Berg believes that institutions like ICRISAT are well-suited to facilitate the transformation of seed from breeder seed to commercial seed. "We are uniquely positioned to bridge the gap between the public and the private sector. This is a mechanism that is innovative. The seed revolving fund allows us to increase the impact of our research by feeding it into the private sector from where it reaches the farmers," says van den Berg.

One of the big challenges for an international research organization is getting improved varieties to the farmer. This is especially true of crops that seed companies are reluctant to invest in. "By taking up the production of foundation seed we can get the right varieties out there," van den Berg says.

Seed companies have been reluctant to multiply seed of self-pollinated crops for the obvious reason that farmers can grow this seed for a few years without coming back for more. "It is hard to ask a seed company to do this because it costs a lot of money to take breeder seed and turn it into commercial seed. There are too many years in which a seed company wouldn't make a profit," van den Berg says. "The seed revolving fund reduces that cost on a seed company by taking responsibility for all those years and steps. We reduce the barriers that would prevent the establishment of seed companies."

Van den Berg's assessment of the seed revolving fund is that it is a pretty good model. "I took into account all costs related to the production of seed including operation costs such as office rent and staff salaries and we can still make a profit that

The two extremes – the commercial farmer and the smallholder farmer

"I've got a policy that we are borrowing the soil from our children," says Gray. "We have got to take care of it." And it seems as though Gray is doing just that. The soil on his farm of 426 hectares is a deep rich healthy red.

In 2008 ICRISAT provided Gray with enough groundnut seed to sow 54 hectares. "We meet ICRISAT's seed needs," he says. In order to fulfill its mandate to serve the smallholder farmer, the Institute also works with commercial growers like Gray to mitigate risk. Gray has 175 acres of irrigated fields on which he grows his groundnut seed. Should the rains fail, Gray, unlike the smaller seed producers like Dr Saka with his minimum of 5 hectares, will still be able to produce seed for the next season.

ICRISAT's Moses Siambi assesses John Gray's crop from the 2008/2009 season. Commercial farmers such as Gray produce 10–15 kg of seed from every kg of groundnut they sow.

This young man strips groundnut for the day to earn some extra cash. On average medium-input farmers produce 8–12 kg of seed from every kg of groundnut they sow.

is reinvested in the seed revolving fund or in the breeding programs. In some ways it is a little model to see how a seed company can work," he says.

Now that ICRISAT has established its name as an organization that is a source of groundnut seed, van den Berg would like the Institute to aim at selling the seed to small seed companies instead of NGOs. For example, some NGOs that buy seed from the fund distribute it to farmers for free, a practice that suffocates the development of a viable, commercial seed sector. But selling to small companies who ultimately sell to the subsidy program can jump-start the seed sector.

According to Isaac Minde, economist and policy expert, "Malawi has been able to demonstrate to the world that subsidies are useful to farming households and are benefiting resource-poor farmers. The country has been able to demonstrate that it is money well spent. It is far better to invest now in good seed systems than later on importing food during a crisis." So far it has been a good start for the legume subsidy program. How far it will continue to impact farmers and promote food security depends on the political climate staying just right.

Biofortified Sorghum – Preparing for the Arrival of Transgenics

Transgenics or genetically modified organisms (GMOs) are the product of transferring one or more genes, usually from wild species or a bacterium, to a crop plant. By 2006, 8% of the global crop area, or 100 million hectares, was planted with transgenics by farmers in 22 countries. Though transgenics have been adopted more rapidly in commercial farming, they have considerable potential for improving the productivity of smallholder farming systems and providing nutritious food to poor consumers in developing countries. However, the environmental, food safety, and social risks of transgenics are controversial and therefore transparent and cost-effective regulatory systems that inspire public confidence are needed to evaluate the risks and benefits.

Slow progress in Africa

Africa has benefited the least from transgenic crops, in part because locally important foods such as sorghum and cassava have attracted little attention from commercial biotechnology firms. The slow progress in the development and adoption of transgenics is due to the neglect of pro-poor traits and orphan crops that are of limited interest to the private sector which is driven by commercial interests. It is also due to the continuing concern about possible food and environmental safety even though available scientific evidence indicates that the transgenics in the market are as safe as conventionally bred varieties and there is no evidence to support harm associated with gene flow to wild relatives when proper safeguards are applied. Other factors contributing to the slow uptake of transgenics include weak regulatory capacity, limited access to proprietary technologies, and complexity of trade.

Environmental risks and benefits need to be evaluated case by case, comparing the potential risks with alternative technologies and taking into account the specific trait and the agro-ecological context in which it will be used.

Biofortification – A tool to improve public health

The agricultural sector can make a major contribution to improving public health in the developing world if the nutritional value of staple foods is improved. This is known as biofortification. The rural poor would be able to benefit from this technology without making any changes to their diets or behavior such as eating new foods or taking supplements which can be expensive.

This is precisely what the Africa Biofortified Sorghum project aims to do. If sorghum, which traditionally has a very low nutritional spectrum, can be bred to provide increased levels of

A field with both cultivated and wild varieties of sorghum with the same flowering/maturity dates allows the movement of pollen across from one to the other, facilitating geneflow.

essential amino acids, especially lysine, vitamins A and E, and enhance the bioavailability of iron and zinc, close to 300 million people in Africa who routinely consume this crop could stand to benefit. "The transgenic approach being used is that the more amounts of micronutrients can be available and absorbed by the human system," says Mary Mgonja, Sorghum Breeder at ICRISAT-Nairobi. "It isn't that more amounts of the micronutrients are produced in the sorghum. It is that they are in a better form to be absorbed. They are bioavailable." So far absorption of these micronutrients has been raised by 20%. The project consortium is working toward a goal of 40%.

Capturing the benefits of GMOs

The new biofortified sorghum will technically be classified as a genetically modified (GM) crop. "GM doesn't just mean that you are adding a new gene or a gene from a different species. The modifications can just be that you are making changes to the existing genes. In the case of sorghum, there is nothing new being added," explains Henry Ojulong, breeder at ICRISAT. As a result of this, there is no need to do any risk assessment on people. However, a risk assessment must be done to determine the effects on the environment especially on the biodiversity within the sorghum species. This is where ICRISAT comes in.

ICRISAT scientists and collaborators (Africa Harvest and Kenyan Agricultural Research Institute) examine a field of parents (cultivated and wild) and hybrid sorghum. These were planted to assess the relative fitness of the hybrids.

Geneflow

Africa abounds with sorghum diversity and this needs to be preserved for use by the current and future generations. Geneflow is a natural movement of genes from one population to another. Whenever a particular variety of sorghum is sown in a field there is the potential for pollen to move from that field to neighboring fields or into uncultivated lands where wild sorghum grows. Mgonja and Ojulong call this the 'classic GM problem'. "If you introduce a new gene or a modification to the gene, then you have to expect that there will be crossing between the cultivated crop and the wild crop," Ojulong says. The research had to answer two questions: how do wild and cultivated sorghums cross in farmers' fields now and how often?

ICRISAT's research as well as others shows that crossing between cultivated and wild populations of sorghum is more the norm than the exception. Any of the characteristics that breeders choose – such as larger heads, grain color, drought-tolerance – routinely cross into wild populations. In other words, any of the modifications to make nutrients bioavailable will probably move into the wild populations of sorghum. The next question that the scientists had to answer was whether or not this would pose a risk to the biodiversity and the environment at large.

There could be two possible outcomes of the movement of genes from a cultivated crop to a wild population. One is that it becomes a superweed. In other words, the wild sorghum inherits certain characteristics such as herbicide-resistance. If the offspring of wild and cultivated sorghum continue to retain this modification, there could be a loss of diversity in the wild

How far does pollen travel?

When assessing the consequences of geneflow on the environment, it is important to know how far pollen can travel from a source such as a cultivated crop to a wild crop. Tests were done in Burkina Faso, Kenya and South Africa to determine this. A cultivated intact crop (acting as a source of pollen) is planted in the middle of a field of male-sterile plants. Sampling at various distances and directions from the pollen source to determine whether fertilization occurred can then show scientists how far the pollen from the transgenics can travel to reach a wild sorghum population.

Results showed that pollen flow was about 40 meters in Kenya and South Africa. However, pollen traveled 100 meters in Burkina Faso, perhaps as a result of Hamattan winds of the Sahel region. Pollen traveled longer downwind than upwind and the distance varied with variety, season and location. This justifies a case by case approach for assessing environmental risk.

Field experimentation to measure distance of pollen flow. The pollen source is planted at the center of the field with eight arms of male sterile lines radiating like spokes on a wheel from the center.

populations. Since sorghum originated in Africa, the genetic diversity of the wild crop is the highest on this continent. Losing any of that diversity could have serious consequences for future breeding programs.

Mgonja and Ojulong made crosses of wild and cultivated sorghum and found that the seeds of these crosses are viable – in other words they will grow and produce more plants which will in turn make more seeds. However, they say that there is no difference in a "reproductive sense". There will be no superweed. Their research also showed that as the progeny of this initial cross of wild and cultivated sorghum successively cross the hybrids become less vigorous. "Basically if you leave it, with time it will become less and less dangerous," Mgonja says.

Next steps

Now that the initial results of the environmental risk assessment have been completed, and once the actual modified sorghum with increased nutritional quality is ready, the next step will be to cross it (under regulated conditions) with existing high-yielding varieties that are currently grown in sub-Saharan Africa and also with the wild and weedy relatives. "It might take 4–5 years to cross into varieties and for the testing and official release," Ojulong says.

This is but the first few steps of a long process. However, as Mgonja puts it, "if we are successful, the benefits on nutrition will be enormous. And we will pave the way for other crops."

Geneflow in Kenya and Mali

Geneflow does not only happen in the field between wild and cultivated sorghum. It can also happen as a result of farmer's behavior. For example, farmers may share seeds with relatives or friends. Or they may mix seeds of different varieties when storing them from one season to the next. The result is that the wild sorghum populations are exposed to different varieties of cultivated sorghum when they are planted. Farmers may also slow geneflow if they remove wild sorghum varieties from around their fields.

This sort of geneflow was taken into account in a study of wild sorghum distribution in Mali and Kenya. The study identified the main regions where wild and cultivated sorghums are found together. It then estimated how closely related the wild sorghum was to the cultivated sorghum races in both countries.

In the second phase of the project, scientists took a closer look at the landscape ecology, *in situ* mating systems and gene flow in 8×8 km study sites. Special attention was given to seed movement of wild sorghum types and to farmer practices used to control wild sorghum. GIS/ remote sensing surveys at both the country and agroecosystem scales played a major role in understanding, predicting and scaling up the process of crop-to-wild geneflow.

The results from this project provide new insights on the determinants and effectiveness of sorghum crop-to-wild gene flow in Mali and Kenya. It serves as a methodological case study of geneflow between an indigenous crop and its wild relatives in the crop center of domestication.

The results confirm that transgenes could spread from GM sorghums into wild and weedy populations. However, this does not imply that there is a risk to the environment. The rate of gene flow will vary both with sites and variety types, and further work is needed to identify the factors influencing this variability.

Dedicated to the memory of Dr Fabrice Sagnard who led this project.

An ICRISAT enumerator records the answers provided by this family during surveys conducted in Kenya.

The National Meteorological Services Take Center Stage

No longer planting blind

"We were not honoring the first rains. We were ignoring it. But now we are planting with the first rains. We are no longer planting blind," says Mwinga Albin, a smallholder in Monze district, Zambia. Lona Mweetwa from nearby Kabika village agrees with him. "Previously when rains started we were just seated. Now we know that that is when business has started. There is no hunger now in our homes."

Farmers in Monze say that they have doubled or tripled their harvests because they have started to use seasonal climate forecasts (SCFs). Issued by the Zambian Meteorological Department before the onset of the rains in September, the SCFs provide farmers with better information about possible planting dates, advice on the right varieties and fertilizer rates for that particular season, as well as information on whether to plant on high or low ground.

This improved use of SCFs by smallholder farmers is the result of a new sort of partnership between the Met departments and agricultural extension and international research organizations. The role of the Met departments in agricultural extension was often limited to simply providing forecasts. In fact, many Met departments often came under the jurisdiction of the ministries of transport and aviation, rather than agriculture.

Mwinga Albin says he trusts seasonal climate forecasts and the Zambian Met Department. He grows cowpeas, velvet beans, sunhemp, soybeans, and groundnuts on his farm. However, like the other farmers in Monze, he measures his success by the number of scotch cart loads that it took to transport his harvest of maize. His previous harvest took four scotch carts. His most recent harvest took eight.

"Historically we have a partnership where we obtained data from the Met departments but we haven't sat down together and used the strengths of each before," says Dr KPC Rao, Scientist at ICRISAT-Nairobi. His work has contributed to building a new partnership with the Kenyan Meterorological Department (KMD) and increasing their capacity. "The demand for Met information is increasing and KMD is beginning to locate its staff outside the main offices and everywhere in country. The department is also starting to conduct training programs with farmers, not just agricultural officers. They are starting to gain an understanding of who the end-users of their products are," Rao says.

The new partnership has resulted in better products that lay out relevant information and choices for clients – a one-stop source of information for farmers. It has helped extension officers get their messages across. Phillimon Hakalembe, Extension Officer for the Mujika Agricultural Camp in Zambia, finds that using SCFs has made it easier for him to teach farmers about new varieties and rainfall patterns. "We are able to provide more accurate and relevant lessons when we design the message according to the rainfall pattern. It has really renewed an interest in our message," he says. He has now been able to engage farmers' interest in other technologies such as growing legumes to promote soil fertility.

A woman farmer explains how seasonal climate forecasts have helped her during a field day at Mujika Agricultural Camp, Zambia.

Durton Nanja, Provincial Met Officer for the Southern Province of Zambia, is also very excited about the results in Monze. "This sort of partnership encourages farmers to consider planning better and making better decisions," he says. "I see that when researchers, agricultural extension, and the met department work together it is a more sustainable scenario and the feedback we have received from field days and from partners confirms this. The met extension service is now better. We are interdisciplinary in practice not just in word."

The Zambian Met Department has grown from eight data collection stations in the southern province to 28 stations. The department even produces their own provincial crop weather bulletin that is issued every ten days. According to Nanja, users find this bulletin more relevant and accurate than the national bulletin for the southern province.

"Durton and his team in the Southern Province of Zambia are really leading the charge in the dissemination of SCF to smallholder farmers," says Dr John Dimes, crop modeler at ICRISAT. "The met bureau was faced with the problem that farmers didn't value their forecasts very much. By working with ZARI (Zambian Agricultural Research Institute) agronomists to do on-farm trials testing management options in response to the SCF, they have managed to change that now."

Better understanding of climate risk

The new partnership with the Met departments also has wider benefits for the research and development community. It provides scientists with a way to evaluate the performance of technologies under various climatic conditions, giving them a greater ability to help farmers through the quantification of climatically induced risks and benefits of adoption.

ICRISAT's clientele – the rainfed farmers – are used to uncertainty. Their way of coping with it is to adopt practices that are risk-averse. While these practices protect them in years of poor rainfall they do not allow them to take advantage of the years of good rainfall. This results in farmers remaining vulnerable, a preservation of the status quo.

"What we need is evidence to show that we've accounted for risk when we are talking to farmers about new innovations in agriculture," says Dr Peter Cooper, Principal Scientist at ICRISAT-Nairobi. "The big question that farmers frequently ask is how many years of out ten am I going to get the rate of return I want if I invest in this new technology. Such information is often the key to helping risk-averse farmers make decisions."

The quantification of climate-induced risk through crop modeling answers that big question. It helps farmers think through their options and make decisions in a much more informed way. The model's capability to provide estimates of the climate risk associated with a management option is dependent on the availability of long-term daily climate data. The Met departments are usually the source of this data.

"So far, it has too often been a case of you've got the information and I'll buy it from you," says Cooper. "But a much better way is to help the Met departments realize their own potential to contribute effectively to the agricultural sector."

One of the ways to do that is the build the capacity of the Met stations to process and store data. Another way is to help them learn new tools and approaches to check the integrity of the data and fill in missing values to improve the quality of the information they provide. ICRISAT is also helping the Met departments learn to use new software to better analyze climate trends and add value to products such as SCFs.

For example, in 2008 around 38 participants from the DRC, Ethiopia, Kenya, Rwanda, Sudan (North), Sudan (South) and Uganda were trained through an electronic course called Statistics in Applied Climatology. The participants were able to understand how to turn data into information for specific end-users, learn statistics and create products of interest to the public. Twenty participants attended another four-week course that introduced them to software such as Genstat and APSIM.

As the Met departments in ESA slowly move center stage and expand their services and its quality, smallholder farmers and extension agents alike will benefit greatly from the new knowledge and options available to them. Fewer farmers will 'plant blind' and extension agents will have more success in getting farmers to see the opportunity for uptake of improved crop management technologies with less risk.

Need for climate data

"One of the shortcomings as a modeler is that it is always very difficult to get good data," says Dr John Dimes. "To use a model, we need to establish local credibility for its use. The best way to do this is to simulate an actual observed yield." This is often difficult because most experiments are not designed to gather enough data on the key input variables that the Agricultural Production Systems Simulator or APSIM model requires. Dimes needs to know how crops perform in different conditions as well as long-term climate information to calibrate APSIM. Once this is done, the model can be used to discuss risk and evaluate technologies with farmers and extension officers.

Dimes has recently been working on calibrating APSIM-Peanut to predict the performance of groundnut, particularly under the highly variable rainfall regime of the semi-arid tropics. Many farmers in Malawi currently grow tobacco as a cash crop, but concerns about monocrop sustainability and reliance on a single cash crop has various stakeholders searching for an alternative cropping option. Groundnut is a good candidate to be one of these. An IDRC-funded project is trying to judge the performance of groundnuts in Malawi under various soil and climate conditions. But to effectively use the model in assessing groundnut performance, long-term daily climate data is another essential ingredient.

"In order to accurately calibrate the model, you need dense climate networks. The denser the network is, the better the model is," says Gray Munthali, Deputy Director of the Malawi Met Services. In order to improve the quality of the data available and to play

On-station experiments provide data on how a crop performs under certain controlled situations. Emmanuel Mukuwamba is responsible for conducting experiments to assess the performance of two varieties of groundnut (Kakoma and CG-7) in three sites (Chitedze, Chitara and Mwimba) under different soil types as well as in four planting dates spread out over four weeks. Mukuwamba measures out 1 meter of each of two rows of uniform groundnut plants which are harvested.

A well-rehearsed series of measurements are then made. The total number of plants in the two rows, the weight of the above-ground biomass, the weight of the pods, and the weight of the nuts themselves are all carefully recorded. In this photograph, the workers cut the root with the groundnuts from the stems so that each can be weighed separately.

their part in the project, Munthali organized his staff members to collect data from alternate sources that had previous been ignored such as schools, religious institutions, commercial farmers.

He was surprised by what they found. "Some farmers even have data for the last 30 years," he says. Most of it was handwritten and Munthali's team made copies of the originals and then painstakingly entered the data into the computer. Using statistical software (Weatherman) and assisted by Roger Stern at Reading University, Munthali's team then assessed the quality of the data and filled in any missing gaps in the records.

This data along with on-farm experiments conducted by Emmanuel Mukuwamba, Senior Research Associate at ICRISAT-Lilongwe, is what Dimes will use to tune APSIM-Peanut. Initial results show that good seasonal conditions and intensive monitoring has provided an ideal data set for calibrating the model. "We have been very lucky actually," says Dimes. "The moisture stress in the rainfed experiments has been minimal. If this wasn't the case, it would have been quite difficult to calibrate the phenology parameters in the model for the different cultivars been tested."

But the most important result has been the deeper understanding gained by the Malawi Met Services. As Munthali puts it, "In meteorology it is the communication of information to partners and to farmers that is the most important. You can't just record information and then not use it. You must use the data and supply a product. We are getting new ideas on how this can happen."

Mukuwamba weighs a sub-sample of five plants to obtain a field-fresh weight of the above ground biomass. He will also later dry the samples in an oven for 48 hours to obtain the dry weight.

Soil sampling can be hard work. In order to look at the nutrients available as well as the water uptake from the day of planting until harvest, Mukuwamba sampled the soils from the top of a row and in a furrow at varying depths until 180 cm. All this data will be provided to John Dimes to use with APSIM-Peanut.

Moving from Theory to Practice: Innovation Platforms for Sustainable Change

Practical considerations

When faced with the rather stark reality of the stagnant landscape of low input systems in southern Africa, researchers and the development community have turned to concepts such as 'linking farmers to markets' and 'market development' in an attempt to create pathways out of poverty for the smallholder farmer. However, the most important question is a very practical one. How does an individual or a project create links to markets or develop markets given the fact that there are so many challenges – poor infrastructure, inappropriate policies, low levels of farmer and market organization and access? How does one make this happen in practice?

This is the question ICRISAT's crop–livestock development group is grappling with in southern Africa. "To reduce poverty, we must bring together theory and practice," says Dr André van Rooyen, Senior Scientist at ICRISAT-Bulawayo. In order to do this, the crop–livestock group is testing an Innovation Platform (IP) approach that focuses on the identification of challenges and opportunities at the two most important points in agricultural development – increased production efficiency and improved markets. While this may not be an

Cattle represent cash to many in southern Africa.

entirely new idea, the IP approach developed by ICRISAT and partners is different in that it does not start with a new technology or strategy. Instead, it allows for the concerned stakeholders to take ownership of the process of defining and prioritizing problems as well as seeking out and evaluating options that will make a difference.

Technology adoption has always been a concern of the research community. Even the best solution is no good if farmers will not use it. The fundamental hypothesis being tested by the IP approach is that farmers will only invest in a particular technology if they are rewarded for it. In other words – they must be paid for their products at the markets in which they sell. Consumer demand for products in terms of quality, quantity, and the timing of production usually determine the extent of these marketplace rewards. "Our work focuses on placing strategic information with regards to production technologies in the context of the local market and then facilitating the process where markets pay for such improvements," van Rooyen says. "This often requires the implementation of sound protocols regarding grades and standards. This is the only sure way in which farmers can realize the benefits of increased investments and therefore pave the way for increased adoption of technologies." When IPs work the role of the research community becomes one of support and facilitation or participatory experimentation within the context of a given production to market or cycle, rather than simple, out of context technology transfer.

Using Value Chain Analyses

The IP approach concentrates on the process of problem identification both at the production as well as market level and collectively seeks solutions and opportunities for real and lasting change. This is achieved through a value chain approach (VCA). "The primary role of the VCA is performance measurement," says Dr Derek Baker, Agricultural Economist at the International Livestock Research Institute (ILRI). "The VCA collects information on activities and products for the IP. It identifies opportunities and constraints in production, trade, processing, and consumption." This analysis will provide the IP with real data on profits and constraints which they can use to evaluate potential solutions.

The LiLi: Markets project has established IPs around existing market structures in three countries – Mozambique, Zimbabwe and Namibia. Each IP involves the players within the 'catchment' of that marketplace. "There is nothing charitable about this process," says van Rooyen. "Each player must have a very clear understanding why he or she attends IP meetings." All can benefit if the transaction costs of the chain are minimized. More efficient value chains will allow more money (and very importantly – more information) to flow through these chains and to the farmers.

Tete, Mozambique

A farmer in Changara District of Tete Province faces a whole host of challenges when attempting to sell livestock. Lack of the right infrastructure such as sale pens, loading ramps, and scales to weigh animals is a serious problem. As is the high cost of permits and taxes imposed by the local authorities. Farmers often choose to slaughter their animals illegally because it is more profitable to do so.

On the surface solving these problems may seem to be far removed from the jurisdiction of research or a research project. However, these are the major obstacles that also hinder the uptake of improved production technologies, a critical issue for research and development. One of the first tasks of the IP in Changara District was to identify the main challenges they felt had to be dealt with to increase farmers' ability to participate in the local markets. They also attempted to identify potential solutions. Their list was as follows:

1. Infrastructure

a. A lack of market infrastructure, sale pens, loading ramps, scales to weigh animals and other livestock working facilities make

Animals at goat markets like this one on the outskirts of Tete are very poorly treated. Markets here are in need of improved infrastructure, holding facilities, water, and scales to improve meat quality and to function optimally.

effective marketing of livestock very difficult.

b. In order to ensure public safety, the number of animals slaughtered illegally must be reduced and meat inspection facilitated.

The solution – construct a small abattoir. The IP identified a team to write proposals to obtain funding to construct an abattoir. This abattoir and other facilities may soon become a reality.

2. Production technologies

a. Animal health remains a major problem. Vaccines are far too expensive and input suppliers are often located far from the producers. The IP suggested that input suppliers attend livestock markets and make their products available during market days.

b. Farmers know that feed is a major limiting factor in producing high quality animals. The IP tasked a responsible party to facilitate the flow of information and technologies to develop improved feeding systems including the planting of fodder shrubs, processing crop residues, and establishing fodder banks.

3. Policies and information

Policies controlling animal movement make it difficult for farmers and traders alike. It is compulsory in Mozambique for animals to be branded when they are moved from one place to the next. The IP decided to facilitate the distribution of branding application forms so that farmers can legally brand their animals and then move them to marketplaces. In addition, the IP suggested greater transparency in the points of sale and sale days. Though seemingly insignificant, this level of market information is often not clear to farmers. Knowing when and where to sell livestock is crucial to 'accessing markets'!

The Changara District IP was able to identify the challenges specific to their area and marketplace. They were also able to identify potentially viable strategies to address these and allocated tasks to concerned members. The process is still continuing with regular IP meetings to improve and monitor the process. As these problems are resolved the next level of problems will be addressed. Once the markets are functioning more efficiently they will create the ideal environment where farmers' efforts will be rewarded. The first steps on the impact pathway have been paved in Tete!

Gwanda, Zimbabwe

If you can not go to the market yourself, perhaps you can bring the market to you! That's what the IP in Gwanda decided to do when they realized that they needed a place from where they could market their goats. Farmers in Gwanda face serious challenges. They lose many animals as a result of not being able to access veterinary supplies and services. Also, the four-month long dry season results in severe shortages in feed. As farmers sell some of their remaining animals to buy food and to pay for medication and education, it is no surprise that herd sizes in Gwanda tend to be rather small and the profits limited.

The IP members in Gwanda decided that they would work together to improve their access to supplies. They would also work together to market their goats. Working with government-based livestock experts, NGOs, as well as ICRISAT, the Gwanda IP established a facility from where goats can be marketed. When the IP meets, they share market information such as when and where sales will take place.

The Gwanda IP has also organized monthly auctions to sell goats and cattle. Instead of attempting to sell one or two animals at the farm gate for a pittance or at great cost at more distant markets, these farmers can now take their animals to an auction organized by the local authorities and the IP. Since farmers now know what their animals are worth, they have at times even refused to sell their animals at unreasonable prices.

Veterinary services attend the auctions and provide permits for animals to be moved. It has

Easy-to-use tools such as this "weigh belt" can help farmers make decisions on supplementary feeding and assess the impact of changes in diets. Promoting animal health and dry season feed was a primary focus of the IP in Zimbabwe.

also attracted numerous other entrepreneurs who sell commodities ranging from clothing, fruit and vegetables, and other foodstuff to agricultural inputs such as vaccines and antibiotics. Farmers with cash in their hands from these sales are now able to immediately reinvest in their businesses by buying supplies to promote animal health.

Hoachanas, Namibia

Many livestock succumb to Namibia's long dry season and frequent droughts. Farmers here are desperate to ensure that their animals have access to feed during these months. The IP in Hoachanas attempted to address this issue by conceiving an improved range management strategy that would provide farmers and their livestock with emergency grazing. The strategy would also provide farmers in the area with a way to manage their rangelands in a more sustainable manner. Consultations and meetings continue to take place with key stakeholders in order to obtain the necessary support to ensure continued cooperation and implementation. While farmers understand the importance of proper range management, managing this resource well only becomes a viable option if the returns on that investment are in the context of the farmer's reality – better prices at markets.

Mr Bertus Kruger, Representative of the Namibian National Farmers Union, provides excellent facilitation skills to ensure that the IP meeting in Hoachanas, Namibia, generates options that are acceptable to all. By including local-level policymakers the IP approach ensures that the solutions developed are sustainable and feasible to all those with a stake in the outcome.

When compared to Mozambique and Zimbabwe, Namibia's livestock sector is well developed. Namibia exports beef to the European Union and farmers who want to benefit from these opportunities need to produce top quality products and adhere to strict grades and standards. While small-scale farmers may not be able to achieve those targets, there are other entry points into the system. For example, small-scale farmers often produce 'weaners' for sale to larger companies which then 'round-off' or fatten animals for sale at local, regional, or international markets. All carcasses are graded and prices paid to farmers are guided by a common grading system. This provides excellent market-based incentives for small-scale farmers to invest in producing higher quality animals and animal products. The difference between a top grade and lowest grade animal of similar weight can be as much as N$2500 (almost US$300 at current exchange rates)!

Not Just for Crop-Livestock Systems

Van Rooyen believes that the IP approach is flexible enough to be used anywhere that farmers produce marketable commodities. "We've found that if you get the relevant stakeholders together, who realize the tangible benefits of participation, the IP approach can solve many production and market related problems," he says. "In Mozambique, Zimbabwe, and Namibia, the IPs were able to address the real day-to-day life issues of farmers and we've seen a lot of changes in how business is done. The real beauty is that this was all generated by the stakeholders themselves and creates an environment where improved production technologies are placed within the context of the farmers' reality."

Appendixes

Publications List 2008

Audi P, Nagarajan L and **Jones RB.** 2008. Seed interventions and cultivar diversity in pigeonpea: A farmer based assessment in eastern Kenya. Journal of New Seeds 9(2):1–16.

Bucheyeki TL, Gwanama C, **Mgonja MA, Chisi M** and **Folkertsma R.** 2008. Morphological characterization of Tanzanian sorghum [*Sorghum bicolor* (L.) Moench] Landraces. Kasetsart Journal Natural Sciences 42:579–588.

Chakraborty Debashis, Gurina Bajaj, Naveen Kalra, Tomar RK, Garg RN, Sahoo RN, Sunayan Saha, Pandey Suraj, Singh Manish, and **Raghuvanshi Ram.** 2007. Impact of tropospheric ozone on growth and yield of crops, The Indian Journal of Crop Science 2(1).

Chirwa Ephraim W, Kumwenda Ian, Jumbe Charles, Chilonda Pius and **Minde Isaac.** 2008. Agricultural growth and poverty reduction in Malawi: Past performance and recent trends 2008. ReSAKSS Working Paper No.6 , IFPRI , Washington , DC. 48 pp. [www.sa.resakss.org]

Cooper P, Dimes J, Rao KPC, Shapiro B, Shiferaw B and **Twomlow S.** 2008. Coping better with current climatic variability in the rain-fed farming systems of sub-Saharan Afric: An essential first step in adapting to future climate change? Agriculture, Ecosystems & Environment 126:24–35.

De Villiers S, Emongor Q, Njeri R, Gwata E, Hoisington D, Njagi I, Silim S and **Sharma K.** 2008. Evaluation of the shoot regeneration response in tissue culture of pigeonpea (*Cajanus cajan* [L.] Millsp.) varieties adapted to eastern and southern Africa. African Journal of Biotechnology 7(5):587-590.

Dimes J and **du Toit P.** 2008. Quantifying water productivity in rain-fed cropping systems in Limpopo Province, RSA. Pages 120–124 in Fighting Poverty through Sustainable Water Use: Volumes I, II, III and IV (Humphreys et al., eds.). Proceedings of the CGIAR Challenge Program on Water and food 2 nd International Forum on Water and Food, Addis Ababa, Ethiopia, November 10–14, 2008. The CGIAR Challenge Program on Water and Food, Colombo. 297pp.

Gurina Bajaj, Kalra N, Chakraborty D, Singh Manish, Mittal RB, Pandey Suraj, Sahoo RN and **Garg RN.** 2007. Tropospheric ozone-Impacting Agriculture. Science Reporter 44.

Homann S, Rischkowsky B, Steinbach J, Kirk M and **Mathias E.** 2008. Towards endogenous livestock development: Borana pastoralists' responses to environmental and institutional changes. Human Ecology 36:4. Springer Verlag, DOI 10.1007/s10745-008-9180-7.

Hove L and **Twomlow S.** 2008. Is Conservation Agriculture an option for vulnerable households in southern Africa? Pages 255–261 in Proceedings of International Workshop on Conservation Agriculture for Sustainable Land Management to Improve the Livelihood of People in Dry Areas, 7–9 May 2007, Damascus, Syria. Arab Centre for the Studies of Arid Zones and Dry Lands and German Agency for Technical Cooperation.

Humphreys E, Peden D, Twomlow S, Rockström J, Oweis T, Huber-Lee A and **Harrington L.** 2008. Improving rainwater productivity: Topic 1 synthesis paper. CGIAR Challenge Program on Water and Food, Colombo. 19 pp. www.waterandfood.org ISBN:1-933699-41-8.

Jayne TS, Chapoto A, Minde I and **Donavan C.** 2008. The 2008-09 food prices and the food security situation in Eastern and Southern Africa. Implications for immediate and longer run responses. Michigan State University International Working Paper No. 96. 63 pp. ISSN 0731-3438.

Kiambi DK, Newbury HJ, Maxted N and **Ford-Lloyd BV.** 2008. Molecular genetic variation in the African wild rice *Oryza longistaminata* A. Chev. et Roehr. and its association with environmental variables. African Journal of Biotechnology 7(10):1446-1460

Lekberg Y, Koide RT and **Twomlow SJ.** 2008. Effect of agricultural management practices on arbuscular mycorrhizal fungal abundance in low-input cropping systems of southern Africa: A case study from Zimbabwe. Biology and Fertility of Soils 44(7):917-923. DOI 10.1007/s00374-008-0274-6.

Longley K, Abele S, Asenso-Okyere K, Dominguez C, Haji H, Hauser S, Mazvimavi K, Ntawuruhunga P, Prabhu R, Setimela P and **Sperling L.** 2008. Agricultural knowledge and learning for disaster preparedness, relief and recovery. Background paper for Flagship 4 of the CGIAR Regional Plan for Collective Action in Eastern and Southern Africa (2007-2009). Alliance of the CGIAR Centers, Nairobi. 51 pp.

Mafongoya PL and **Hove L.** 2008. Tree foliage polyphenols and nitrogen use in crop-livestock systems of southern Africa: strategies for increasing efficiency. Pages 207–227 *in* Toward agroforestry design: An ecological approach (Jose S and Gordon AM, eds.). Dordrecht, Netherlands: Springer Science+ Business Media BV. ISBN:978-1402065712.

Manish Singh, Kalra N, Chakraborty D, Kamble K, Barman D, Saha S, Mittal RB and **Pandey S.** 2008. Biophysical and socio-economic characterization of water stressed and simulating agri-production estimates and landuse planning under normal and extreme climatic events: a case study. Environment Monitoring Assessment 142:97-108.

Mati BM.2008, Capacity development for smallholder irrigation in Kenya. Irrigation and Drainage. IRD 57(3): 332-340. Published by Wiley InterScience.

Mati BM, Mutie S, Gadain H, Home P and **Mtalo F**. 2008. Impacts of land-use/cover changes on the hydrology of the Mara River. Lakes & Reservoirs-Research and Management 13: 169–177. Published by Blackwell Publishing Asia Pty Ltd.

Mazvimavi K and **Twomlow S.** 2008. Conservation farming for agricultural relief and development in Zimbabwe. Pages 544, Special Publication No.3 in No-till farming systems (Goddard T, Zoebisch MA, Gan YT, Ellis W, Watson A and Sombatpanit S, eds.). World Association of Soil and Water Conservation, Bangkok. ISBN:978-974-8391-60-1.

Mazvimavi K, Twomlow S and **Hove L.** 2008. Assessing the promotion of conservation farming adoption among smallholder farmers in Zimbabwe. A report submitted to FAO. ICRISAT Bulawayo. 31 pp.

Mazvimavi K, Twomlow S and **Ndlovu P.** 2008. Farmer knowledge and adoption of fertilizer microdosing technology in Zimbabwe. A report submitted to FAO and MTLC. ICRISAT Bulawayo. 37 pp.

Mazvimavi K, Twomlow S, Belder P and **Hove L.** 2008. An assessment of the sustainable uptake of conservation farming in Zimbabwe. Global Theme on Agroecosystems report No. 39. ICRISAT Bulawayo, P O Box 776, Bulawayo, Zimbabwe.

Mgonja MA, Chandra S, Obilana AB, Monyo ES, Kudita S, Chisi M, Saadan HM and **Chinhema E.** 2008. Stratification of sorghum hybrid testing sites in southern Africa based on grain yield. Field Crops Research 108:193–197.

Minde IJ, Jayne TS, Crawford E, Ariga J and **Govereh J.** 2008. Promoting fertilizer use in Africa: Current issues and empirical evidence from Malawi , Zambia and Kenya. ReSAKSS-SA Working Paper No.13. ReSAKSS-SA Pretoria, South Africa. 35 pp. [www.sa.resakss.org]

Minde IJ, Twomlow S, Mazvimavi K and **Pedzisa T.** 2008. Increasing the impacts from soil fertility research in Southern Africa. Report No. 1. IDRC and ICRISAT Bulawayo. 47 pp.

Mupangwa W, Twomlow S and Walker S. 2008. Conservation tillage for soil water management in the semi arid Southern Zimbabwe. Journal of Physics and Chemistry of the Earth 33:762–767.

Ojulong H, Labuschangne MT, Fregene M and **Herselman L.** 2008. A cassava clonal evaluation trial based on a new cassava breeding scheme. Euphytica 160:119–129.

Ojulong H, Labuschangne MT, Fregene M and **Herselman L**. 2008. Introgression of genes for dry matter content from wild cassava species. Euphytica 164:163–172.

Osiru MO, Adipala E, Olanya OM, Reeder R, Lemaga B and **Kapinga R.** 2008. Leaf petiole and stem blight disease of sweet potato caused by *Alternaria bataticola* in Uganda. Plant Pathology Journal 7(1):118–119.

Osiru MO, Olanya OM, Adipala E, Lemaga B and **Kapinga R.** 2008. Stability of sweet potato cultivars to *Alternaria* leaf and stem blight disease. Journal of Phytopathology 157:172-180.

Pedzisa T, Minde IJ, Twomlow S and **Mazvimavi K.** 2008. Participatory technology development and transfer: The key to soil fertility and water management technology adoption in Zimbabwe. Report No. 2. IDRC and ICRISAT Bulawayo. 40 pp.

Prasad S, Thenkabail, Chandrashekar M, Biradar, Praveen Noojipady, Xueliang Cai, Venkateswarlu Dheeravath, Manohar Velpuri, Muralikrishna Gumma and **Pandey Suraj.** 2007. Sub-pixel Area Calculation Methods for Estimating Irrigated Areas. Sensors 7:2519-2538.

Rao KPC. 2008. Changes in the Dryland Agriculture in Semi-Arid Tropics (SAT) of India: 1975-2004, European Journal of Development Research 20(4):562-578.

Sahoo RN, Tomar RK, Pandey S, Sahoo PM, Chakraborty D and **Kalra N.** 2007. Precision farming: Concept and application in Indian context. The Indian Journal of Crop Science 2(1).

Shiferaw B, Bantilan C and **Wani S.** 2008. Rethinking policy and institutional imperatives for integrated watershed Management: Lessons and experiences from semi-arid India. Journal of Food Agriculture & Environment 6(2):37–377.

Shiferaw B, Kebede T and **Reddy VR.** 2008. Community watershed management in semi-arid India: The state of collective action and its effects on natural resources and rural livelihoods. CAPRi Paper No. 85. www.capri.cgiar.org/pdf/overw_poverty.pdf

Shiferaw B, Kebede TA and **You Z.** 2008. Technology adoption under seed access constraints and the economic impacts of improved pigeonpea varieties in Tanzania. Agricultural Economics 39:1-15.

Shiferaw B, Obare G and **Muricho G.** 2008. Rural market imperfections and the role of institutions for collective action to improve markets for the poor. Natural Resources Forum 32:25–38 (A United Nations Sustainable Development Journal).

Shiferaw B, Okello J and **Reddy VR.** 2008. Adoption and adaptation of natural resource management innovations in smallholder agriculture: Reflections on key lessons and best practices. Environment Development and Sustainability. DOI- 10.1007/s10668-007-9132-1.

Shiferaw B, Okello J, Muricho G, Jones R, Silim S and **Omiti J.** 2008. Unlocking the potential of high value legumes in the semi-arid regions: Analyses of the pigeonpea value chains in Kenya. Socioeconomics and Policy Research Report 1. ICRISAT, Patancheru India.

Shiferaw B, Reddy VR and **Wani S.** 2008. Watershed Externalities, Shifting Cropping Patterns and Groundwater Depletion in Indian Semi-Arid Villages: The Effect of Alternative Water Pricing Policies. Ecological Economics 67(2):327-340.

Twomlow S, Love D and **Walker S.** 2008. The nexus between IGNRM and IWRM in southern Africa. Journal of Physics and Chemistry of the Earth 33:889-898.

Twomlow S, Mugabe F, Mwale M, Delve R, Nanja D, Carberry P and **Howden M.** 2008. Building adaptive capacity to cope with increasing vulnerability due to climatic change in Africa – a new approach. Journal of Physics and Chemistry of the Earth 33:780–787.

Twomlow S, Rohrbach D, Dimes J, Mupangwa W, Ncube B, Hove L, Moyo M, Mashingaidze N and **Mahposa P.** 2008. Micro-dosing as a pathway to Africa's Green Revolution: evidence from broad-scale on-farm trials. Nutrient Cycling in Agroecosystems DOI: 10.1007/s10705-008-9200-4.

Twomlow S, Shiferaw B, Cooper P and **Keatinge JDH.** 2008. Integrating genetics and natural resource management for technology targeting and greater impact of agricultural research in the semi-arid tropics. Experimental Agriculture 44(2):235–256.

Twomlow S, Urolov JC, Jenrich M and **Oldrieve B**. 2008. Lessons from the field – Zimbabwe's Conservation Agriculture Task Force. E-Journal of SAT Agricultural Research. 6:1-11. http://intranet/Journal/Volume6/aes/Twomlow.pdf

Verchot L and **Cooper P.** (eds). 2008. International agricultural research and climate change: A focus on tropical systems. Special Issue: Agriculture, Ecosystem & Environment 126 (1-2):138. www.science-direct.com

Waliyar F, Siambi M, Jones R, Reddy SV, Chibonga D, Kumar PL, Denloye S and **Chinoko Y.** 2008. Institutionalizing aflatoxin testing in Africa. Pages 359–368 *in* Mycotoxins: Detection methods, management, public health and agricultural trade (John F Leslie, Bandyopadhyay R and Visconti A, eds.). CABI Publishing, UK. ISBN:978-1845-930-820.

Wani SP, Shiferaw B and **Sreedevi TK.** 2008. Opportunities for the private sector in soil and water conservation programs in rainfed areas. Journal of Financing Agriculture 40:3-12.

Wani SP, Shiferaw B, Sreedevi TK, Pathak P, Singh P, Sahrawat KL and **Mula RP.** 2008. Poverty pathways and desertification: strategy to break the unholy nexus. Pages 28–45 *in* Converting deserts into oasis (Yadav JSP, Singh RK and Gupta VP, eds.).

Staff List 2008

ICRISAT–Nairobi

Administration

Director–ESA	S.N. Silim
Assistant Director–ESA	R.B. Jones
Regional Administrator	P. Ndung'u*
Administrative Assistant	L. Bwire
Assistant Accountant	J. Mwangi
Accounts Assistant	A. Gakinya
Driver/General Assistant	A. Mutuku
Driver/General Assistant	D. Kisavi

Research Division

Regional Research Program Coordinator and Principal Scientist	M. Mgonja
Regional Research Program Coordinator and Senior Scientist	B. Shiferaw
Principal Scientist	P. Cooper
Senior Scientist	K.P.C. Rao
Molecular Geneticist	D. Kiambi
Regional Scientist	S. de Villiers
Regional Scientist	K. Semagn*
Regional Scientist Project Leader LLP	S. Githiri*
Special Project Scientist	C. Longley
Project Manager	T. Abate**
Post-Doctoral Fellow	H. Ojulong**
Scientist	G. Rao**
Visiting Scientist	J. Okello*
Regional Facilitator–IMAWESA	B. Mati
Associate Professional Officer	M. van den Berg
Associate Professional Officer	P. Dixit
Research Associate	P. Audi
Research Associate	G. Muricho
Scientific Associate	E. Manyasa
Technical Officer	J. Kibuka
Research Technician	M. Somo
Research Technician	P. Kaloki
Research Technician	R. Mutegi
Research Technician	A. Oyoo
Research Technician	D. Ojwang
Research Technician	M. KItavi*
Research Technician	M. Mbogori*
Research Technician	M. Kamau*

ICRISAT–Bulawayo

Administration

Principal Scientist & Country Representative	I.J. Minde
Country Administrator	A. Nyagadza
Snr. Finance Officer	I. Tapela
Snr. Associate Finance	M. Sigauke
Finance Officer	O. Katsaura
Finance Officer	O. Ncube
Snr. Administrative Associate	Z.I. Mabhikwa
Officer (Admin)	S.L. Ncube
Administrative Associate	C. Ndwalaza
IT Manager	K. Mhuruyengwe
Snr. Technician (Mechanic)	C. Mabika
Administrative Assistant	C. Donono
Office Assistant	A. Khanye
Stores Assistant	S. Mnkandla
Office Assistant	J. Ndlovu
Fleet & Workshop Assistant	M. Mpofu
Driver	J. Masuku
Driver	P. Chirwa
Driver	M. Mlotshwa
Driver	T. Mpofu
Driver	M. Manyani
Office Assistant (Cleaner)	T. Ndlovu
Office Assistant (Cleaner)	S. Ndlovu
Field Supervisor	Q. Nkomo
Tractor Driver	J. Mpofu
Field Recorder	B. Ncube
Field Recorder	G. Mpofu
Laboratory Assistant	J. Ndlovu

Electrician	D. Sibanda**
Logistics & Procurement Officer	C. Muvami**
Regional Editor	S. Sridharan

Research Division

Global Theme Leader	S.J. Twomlow
Senior Scientist	A. van Rooyen
Senior Scientist	J.P. Dimes
Regional Scientist	L. Hove
Regional Scientist	K. Mazvimavi
Regional Scientist	S. Homann
Associate Professional Officer	S. Pandey**
Scientific Officer	S. Kudita
Scientific Officer	W. Mupangwa
Scientific Officer	T. Musitini
Scientific Officer	M. Moyo**
Scientific Officer	P. Nyathi
Scientific Officer	E. Masvaya
Scientific Officer	P. Ndlovu
Scientific Officer	A. Sibanda
Scientific Officer	A. Chirima
Scientific Officer	T. Pedzisa
Scientific Officer	C. Ngulube**
Consultant	M. Madzvamuse

ICRISAT-Lilongwe

Administration

Country Representative	M. Siambi
Finance/Administration Officer	B. Kachale
Accounts Assistant	T. Dambe
Administrative Assistant	H. Warren
Associate (Administration)	L. Chiwaya
Driver/General Assistant	P. Nkhoma
Driver/General Assistant	G. Nanthoka
Senior Guard	R. Mandala
Guard	H. Nankwenya
Guard	B. Chakongwa
Guard	M. Bello

Research Division

Principal Scientist-Breeding	E. Monyo
Associate Professional Officer	M. Osiru
Associate Professional Officer	J. Verheijen
Senior Scientific Officer	O. Madzonga
Senior Scientific Officer	E. Chintu
Scientific Officer	H. Charlie
Scientific Officer	H. Msere
Scientific Officer	W. Munthali
Scientific Officer	C. Mukhala
Senior Associate (Research)	H. Chipeta
Senior Associate (Research)	E. Mkuwamba
Senior Associate (Research)	E. Chilumpha
Senior Associate (Research)	L. Gondwe
Senior Associate (Research)	T. Chirwa
Associate (Research)	C. Kamanga
Associate (Research)	E. Kumitete
Associate (Research)	R. Chirambo
Associate (Research)	I. Kimbwala
Associate (Research)	H. Mulenga
Associate (Research)	P. Gonani

ICRISAT-Mozambique

Administration

Country Representative	C. Dominguez
Accountant and Administration	I. Lopes
Driver	S.P. Vilanculos
Driver	C. Ramos

Research Division

Scientific Officer	W. Leonardo
Scientific Officer	C. Ruface
Scientific Officer	T. Campos
Technical Assistant	A. Castro
Technical Assistant	L. Benjamin*

Note:

** Staff member left during the year and ** Staff member joined during the year*

About ICRISAT

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 600 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT is supported by the Consultative Group on International Agricultural Research (CGIAR).

Contact Information

ICRISAT-Patancheru (Headquarters)
Patancheru 502 324
Andhra Pradesh, India
Tel +91 40 30713071
Fax +91 40 30713074
icrisat@cgiar.org

ICRISAT-Liaison Office
CG Centers Block
NASC Complex
Dev Prakash Shastri Marg
New Delhi 110 012, India
Tel +91 11 32472306 to 08
Fax +91 11 25841294

ICRISAT-Nairobi (Regional hub ESA)
PO Box 39063, Nairobi, Kenya
Tel +254 20 7224550
Fax +254 20 7224001
icrisat-nairobi@cgiar.org

ICRISAT-Niamey (Regional hub WCA)
BP 12404, Niamey, Niger (Via Paris)
Tel +227 20722529, 20722725
Fax +227 20734329
icrisatsc@cgiar.org

ICRISAT-Bamako
BP 320
Bamako, Mali
Tel +223 20 223375
Fax +223 20 228683
icrisat-w-mali@cgiar.org

ICRISAT-Bulawayo
Matopos Research Station
PO Box 776,
Bulawayo, Zimbabwe
Tel +263 83 8311 to 15
Fax +263 83 8253, 8307
icrisatzw@cgiar.org

ICRISAT-Lilongwe
Chitedze Agricultural Research Station
PO Box 1096
Lilongwe, Malawi
Tel +265 1 707297, 071, 067, 057
Fax +265 1 707298
icrisat-malawi@cgiar.org

ICRISAT-Maputo
c/o IIAM, Av. das FPLM No 2698
Caixa Postal 1906
Maputo, Mozambique
Tel +258 21 461657
Fax +258 21 461581
icrisatmoz@panintra.com

www.icrisat.org

J 307-2009