ICRISAT West and Central Africa 2010

# Towards greater impacts

ICRISAT
Science with a human face

International Crops Research Institute
for the Semi-Arid Tropics

*Women selling Pomme du Sahel in Niger*

## About ICRISAT

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

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

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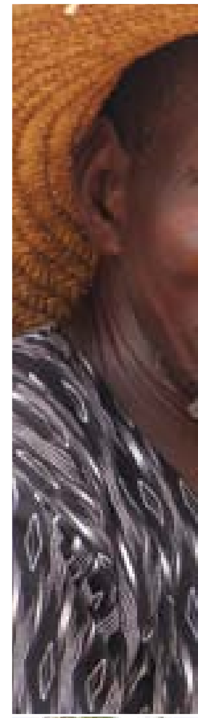

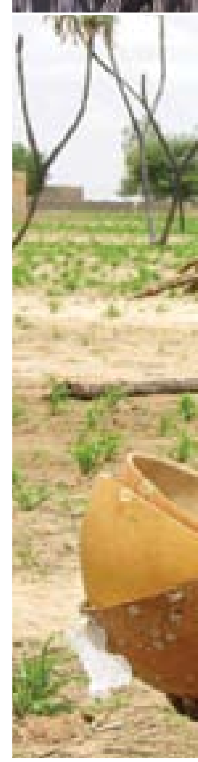



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# Contents

# Message from the Director General

The West and Central Africa (WCA) region is at a major turning point, moving rapidly away from subsistence farming to sustainable agricultural development. For a long time, smallholder farmers in this part of the world have been left behind when it comes to market opportunities. But as this 2010 report vividly demonstrates, the region is on its way to inclusive, market-oriented agricultural growth.

This past year, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has gathered momentum in our quest to find new ways to combat poverty in the dryland tropics. Our new Strategic Plan to 2020 is anchored on a conceptual framework that we call 'Inclusive Market-Oriented Development', or IMOD. This promotes a progression from subsistence to market-oriented agriculture, empowering smallholder farm families and building their resilience on the path to prosperity. Through this inclusive development strategy, we are engaging and supporting smallholder farmers in WCA to achieve food security and improved livelihoods while using their own resources in more strategic ways.

Our programs and activities in the region are already showing promising results. In this annual report, discover how a groundnut seed project is making a difference to the livelihoods of farmers in the Sahel, and how fertilizer microdosing is bringing hope to the farmers, while scientists are working to find new genes against drought and aflatoxin.

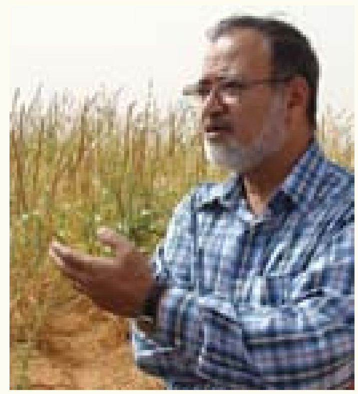
This report also highlights some of ICRISAT-WCA's major achievements in improving productivity and diversifying farming systems in the region through better access to quality seeds. By making improved seeds available to smallholder farmers in the drylands, we are also helping them cope with climate change. You can read about our project in the Sahel to improve seed varieties and nutrient management options, which are increasing yields and benefitting livelihoods in the area.

ICRISAT-WCA is committed to harnessing complementary and purposeful partnerships for greater impacts, particularly with farmers' organizations in the drylands.

As ever, we are thankful to our donors, partners and the Governing Board for their support and guidance in fulfilling our mission to help millions of poor people in the dryland tropics achieve food security and prosperity. We hope you enjoy reading this report and we look forward to more successes and greater impacts in 2011.

**William D Dar**
Director General

# Message from the Director West and Central Africa



Major climatic variability and events characterized 2010 in WCA – major floods early in the rainy season and scattered droughts throughout the cropping season. And in some parts of the region, the late start of the rains reduced crop yields.

But there is a glimmer of hope: ICRISAT-WCA is delighted to host the regional programme of the Climate Change Agriculture and Food Security programme, based at our Niamey Center in Niger. This programme will coordinate and unite regional efforts around these issues.

With our activities in the region expanding, we re-opened our office in Kano, Nigeria. This followed the signing of a Memorandum of Understanding between ICRISAT and the Agricultural Research Council of Nigeria (ARCN).

One of our focuses in 2010 was strengthening partnerships. We tightened our collaborations with several national agricultural research systems (NARS), as well as other regional and sub-regional organizations. Several visits were made to other main partners: details of some of these visits are highlighted throughout the report.

In March, ICRISAT and the World Vegetable Center (AVRDC) were awarded the prestigious 'Science Award for Outstanding Partnership' for work to improve the lives of women and children in West Africa. During the past five years, we have also been working closely with other centers supported by the Consultative Group on International Agricultural Research (CGIAR); for example, in a joint programme with the World Agroforestry Center (ICRAF), we created a position for an agro-forester, based at ICRISAT's Sahelian Centre in Niger.

Our partnerships with farmers are also stronger than ever. As an example, the partnership between ICRISAT-Niger, the Institut National de Recherches Agronomiques du Niger (INRAN) and Fuma Gaskiya, a farmers' organization, won ICRISAT's prestigious 'Outstanding Partnership Award' in 2010. Similar partnerships are being put in place with various organizations throughout the region – vital examples of 'science with a human face' – science that has a direct impact on local people while creating international public goods.

To further develop this approach to science, the number of trainees at ICRISAT-WCA increased significantly in 2010: 65 new trainees were registered within our centers in the region during the past 12 months.

ICRISAT's strategic plan clearly places farmers at the front. Our annual report therefore focuses on African smallholders' needs and expectations: how to get better seeds of improved varieties, how to access agricultural credit, how to reach markets, how to benefit more from their crops. This report will take you on a journey through the challenges and opportunities millions of farmers in West and Central Africa face every day. I hope you enjoy reading this report and learn a little more about ICRISAT-WCA's main achievements in the Sahel.

**Farid Waliyar**
Director, ICRISAT West and Central Africa

# Groundnut seeds make a difference to women farmers in Mali and Niger

Groundnut in WCA is mostly grown and processed by women. It is one of the main sources of income that women control, and the earnings improve their livelihoods, even reaching disadvantaged community members. But these benefits have not come easily; providing women farmers with new groundnut varieties has been a real challenge.

## Access to seeds

Several studies in West Africa indicate that the lack of access to, and unavailability of, improved seed varieties are major constraints to the adoption of modern crop varieties.

For low-value crops such as groundnut, the success in building sustainable seed production and delivery schemes has been limited. And the schemes developed for high-value crops may not be appropriate for low-value crops, which have poorly developed product markets.

The characteristics of each crop also pose challenges to developing sustainable seed supply schemes. For example, groundnut has a low multiplication rate, so farmers need 60–80 kg of seed to plant 1 ha, compared to just 4 kg for pearl millet. Losses during transport to market are high, as groundnut seeds break easily. They lose their viability quickly, making it difficult to keep seeds for more than six months without appropriate storage facilities. And farmers also need varieties with low genetic deterioration rates, so they can plant the same variety for more than six years without it losing its genetic purity. These characteristics have limited the involvement of the private sector in the groundnut seed industry and community-based organizations (CBOs) have struggled to fill the seed gap.

## Community-based seed schemes

To address this, the Tropical Legumes II programme, run by ICRISAT and partners, set up two pilot schemes between 2007 and 2010 to test informal seed production schemes. In Dosso, Niger, ICRISAT established a community-based groundnut seed production and multiplication scheme. Farmers selected their preferred groundnut varieties, based on plant and seed traits (such as pod yields and disease resistance) as well as their suitability for making processed products (cakes and oil).

The farmers then worked on seed production and marketing. Twenty-eight CBOs – of which 19 were women's groups and nine mixed gender, and 20 small-scale women seed producers – were trained in seed production technology, small business management and marketing skills. Partnerships were key to the project:

- Farmers' groups and small-scale seed producers were tasked with seed production; INRAN and ICRISAT supplied breeder seeds.

*A woman farmer carrying her groundnut product during harvest time in Mali, October 2010*

- Traditional extension services carried out training on seed production techniques and monitoring of seed production plots.
- The West Africa Seed Alliance (WASA) Seeds project trained the 28 CBOs, farm-input shop tenants and local traders in seed processing (packaging, labeling and branding), marketing and small-scale business skills.
- Rural radio stations, including FARAA', GAYA and Dosso, disseminated information on the seed varieties sold, the location of seed sales and groundnut crop management techniques.
- Seed producers including the farmers' groups and small-scale seed producers were linked to farm-input shops to market the seeds; they could also sell seeds through village markets.

This scheme has been very successful. After four years, the CBOs have produced more than 100 tons of certified groundnut seed – about 65% of the total certified seed produced in Niger[1] – and the quality is very good. More than 200 tons of quality declared seed have also been produced in the region.

Thirty women processors tested these varieties for their suitability for making oil and paste. The results indicate that Fleur 11, RRB, ICG 9346, J11 and TS32-1 were superior to 55-437 and seed purchased from the local GAYA produced better oil color and fluidity. The variety 55-437 was ranked first for groundnut paste, followed by RRB, J11, the local variety bought in the market, Fleur 11 and ICG 9346. The varieties RRB, ICG 9346, J11 were selected for seed production and marketing.

### Sustainability of such schemes

When the project ends in 2011, the CBO scheme will also end. To be sustainable beyond this, the links established between partners will need to be maintained, and INRAN will have to provide a consistent supply of breeder seed to CBOs (which may need to be subsidized). But the key to long-term sustainability will be a more efficient product market and greater private sector involvement in seed supply and processing industries.

***Bonny Ntare, Jupiter Ndjeunga***

### Extending the scheme in Mali

Following this success, the scheme was extended to five villages in Mali's Koulikoro region. This scheme, involving 150 women, was a partnership between ICRISAT and Plan Mali. It started in 2009 in two villages and was extended to four more in 2010.

Five groundnut varieties (ICGV 86124, ICGV 86024, ICGV 85015, ICG 7878, Fleur 11) were grown in 0.1 ha plots. A preference assessment showed that the ICGV 86024, ICGV 86124 and Fleur 11 varieties were the most preferred across the villages. Their pod yield varied between 600 kg/ha to 2045 kg/ha, with the best yield obtained in the initial two villages. The average yield advantage of the introduced varieties over the local variety ranged from 15–25%.

Exposure to the new varieties has heightened enthusiasm among the women's groups in Plan Mali's intervention zone, with prospects for income generation as well as improving nutrition for children and their mothers.

1 Republic of Niger, Ministry of Agriculture and Livestock. *Directory on the Availability of Improved Seed*. 2010/11.

# Access to improved seeds increases productivity and system diversification in Nigeria

Seeds are the basic input for agricultural production. The performance of all other inputs – from fertilizers to pest control methods – depends on the traits of the seeds the farmer planted. Nigeria's current population is over 150 million, of whom 70% depend on farming for their livelihood. Providing them with improved seed varieties is essential for increasing the productivity of their farms.

Quality seeds of improved varieties have advantages over local varieties, including higher grain yields, earlier maturity, and greater tolerance to stress or disease. For

36 years there have been concerted efforts to develop an organized seed distribution system in Nigeria, but it remains grossly inadequate. Improved seeds from the seed companies currently operating only reach the headquarters of state and local governments. This leaves rural farmers with little option but to use saved seeds or local markets. The seed companies also end up with large volumes of unsold stocks each year.

Realizing Nigeria's seed supply system needed diversifying; the ICRISAT-WASA Seeds Project was created to train agro-dealers to supply seeds to rural farmers. The project, funded by USAID-MARKETS Nigeria, aims for agro-dealers to become more familiar with seed companies' products, and for the seed companies to use agro-dealers as rural marketing outlets.

### Varietal distribution programme

The varietal distribution programme was designed to provide the necessary links between seed companies and agro-dealers in the marketing of certified seeds to rural farmers. Working in Kano and Kaduna states during the pilot stage, the project team identified seed companies to provide the necessary links.

One of the key deliverables was training workshops for agro-dealers. A total of 251 participants attended, of which 222 were men and 29 women. Trainers were drawn from national institutes, agro-chemical companies and ICRISAT staff. Six seed companies[2] exhibited their products at the training workshops.

The participating agro-dealers and seed companies made several business transactions during the workshops. Consequently, all of the seed companies have reported increased product sales through the agro-dealers. This benefits not only the dealers and seed companies, but also rural farmers, who now have access to improved seeds through these distribution networks. Farmers who buy improved seeds are also more likely to invest in other inputs and use improved agronomic practices. The seed companies are therefore being encouraged to increase or setup more networks through agro-dealers.

***Hakeem Ajinde Ajeigbe***

## Turning to improved seeds in Kano state

*"Since I turned to the use of these improved varieties, I have made some savings and I am changing my house gradually from mud to a block house. I am also going into the goat-selling business to augment my income and to keep me busy throughout the year."* – Kabiru Garba Kwa, farmer

WASA works with government agencies, private seed companies and agro-dealers to deliver high quality seeds to farmers in Nigeria. In Kwa, a town in Kano state, the ICRISAT-WASA Seed Project set up a demonstration of improved maize, cowpea, groundnut and millet seeds, with field days to popularize the use of these improved seeds.

Kabiru Garba Kwa was one of the farmers who got some seeds through the programme. At a farmer field day held in 2009, he was so impressed with the performance of the improved varieties that he now uses these seeds.

Karibu was particularly keen on the performance of two varieties – ICSV 400 sorghum and SOSAT C88 millet – because of their high grain yields, early maturity and good food qualities. "One of the problems we face is dwindling rainfall, but with the improved varieties, no matter how short the rains, I am sure to harvest", he says.

He gets his seed from the agro-dealer based in his village and also gets some technical advice, as the dealer doubles as a village extension agent for Kano State Agricultural an Rural Development Authority. "Most of the farmers in the area are now willing to buy quality seed, because we are sure to harvest a good crop", says Karibu.

*Kabiru Garba Kwa, a seed producer in Nigeria*

# Pomme du Sahel proliferates in Niger

## An ICRISAT success story

Jujubier (*Ziziphus mauritiana*) is a wild tree found in the semi-arid tropics of Africa and South Asia. The tree produces very small edible fruit, but these have little commercial value; in West Africa, they are often used as goat food. But an ICRISAT project has developed a larger variety of the fruit for humans to eat – the 'Pomme du Sahel'.

Jujubier grows in regions with 200 mm annual rainfall and above, and it is tolerant to drought and waterlogging. After Jujubier trees were domesticated in India, they produced fruits up to 20 times larger than wild trees. These fruits contain ten times more vitamin C than apples and are rich in calcium, iron, fibers and carbohydrates. They can be eaten fresh or dried, making them a versatile and potentially useful source of food and nutrition.

### Grafting Jujubier

ICRISAT introduced the domesticated Jujubier to Burkina Faso, Mali, Niger and Senegal. To improve the image of the fruit, ICRISAT named it the 'Pomme du Sahel' – French for 'Apple of the Sahel'. In 2003, ICRISAT started a campaign to disseminate the trees in Niger. A Pomme du Sahel plant nursery was established in the Sadoré experimental station and several local women have since been trained to graft the domesticated trees from India on local rootstock. About 50,000 grafted plants have been sold each year since 2003.

In the last eight years, Pomme du Sahel has become a popular food in Niger. But there are problems for people trying to grow it. Small trees growing unprotected in fields are destroyed by grazing animals, and it takes about seven years for the trees to reach full fruit production. To solve these problems, we grafted the domesticated tree on the wild Jujubier trees that abound in fields in Oualam and Tera, two poor regions of Niger.

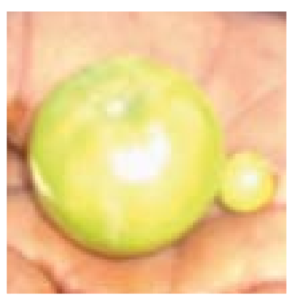
### Training grafters

In May and June 2010, ICRISAT brought 40 young people from each region to our station in Sadoré and trained them to graft mature Jujubier trees. The new grafters each received a set of pruning and grafting equipment and returned to their villages to start grafting the large trees growing in farmers' fields. The grafters received 1,000 West African CFA francs (FCFA) – around $2 – for each successfully grafted tree.

About 300 trees were grafted in each region during the first year, with a 50% success rate. This is reasonable, considering the grafters' lack of experience. The leaves of Jujubier are very nutritious to livestock that graze on them after they drop in the dry season, so they do not eat the trees themselves. And the trees gave fruit six months after grafting! A mature grafted tree yields about 20 kg of fruit per year, which is sold at 500 FCFA (around $1) per kg. Five grafted Jujubier trees bring about the same revenue as 300 kg of millet.

The success of the first year prompted many farmers in the two regions to graft their trees during the 2011 season, with help from the trained grafters. We expect this process to spread further in the two regions without external intervention. And if the initiative is taken up by development agencies, the practice should spread over Niger and beyond.

***Dov Pasternak, Seydou Abdousallam***



*Fruit from a domesticated jujubier (left) next to the smaller fruit from a wild jujubier*

*A Tillabery farmer by his wild jujubier grafted with Pomme du Sahel, five months after grafting*

# New genes for resistance to drought and aflatoxin

Groundnut grows widely in the rain-fed regions of the semi-arid tropics that are characterized by unpredictable droughts. The plant is well suited to these conditions; under drought stress, pod water activity decreases in response to the reduced plant-water status of the drying soil.

But this reduction in water activity reduces phytoalexin production, creating favorable conditions for the growth of *Aspergilus flavus* and the production of aflatoxin (a toxic substance produced by the mould fungi *Aspergilus flavus* and *Aspergilus parasiticus*).[2]

Aflatoxin contamination increases under drought stress[3] and when drought is combined with high temperatures, it creates ideal conditions for aflatoxin contamination. These conditions are common in West Africa. Breeding groundnut for drought tolerance and aflatoxin resistance would have a wide impact on crop yield and quality, increasing productivity and enhancing the economic well-being and health of smallholder farmers.

Figure 1. The effects of drought stress on pod and haulm yield


WW = well water, WS = water stress (intermittent drought). ICG 13941 is one of the drought-tolerant genotypes.

## Testing for drought tolerance

Identifying drought-tolerant traits that contribute to aflatoxin resistance may help to develop more efficient aflatoxin-resistant genotypes. An ICRISAT study aimed to:

- investigate variation in drought tolerance and aflatoxin contamination in groundnut cultivars;
- identify new sources of tolerance or resistance to drought and aflatoxin that could be used in breeding programmes in West Africa;
- investigate the relationship between drought-tolerance traits and aflatoxin contamination.

From February to June 2010, we undertook field screenings of 324 groundnut genotypes, along with 37 varieties from INRAN and 22 varieties preferred by farmers in Niger and India. These screenings took place at the ICRISAT Sahelian Centre in Sadoré.

We imposed two water treatments: full irrigation (WW) until harvest, and intermittent drought stress (WS) from flowering to maturity. Traits measured during crop growth included SPAD chlorophyll meter readings, specific leaf area, time to flowering, partition rate and pod growth rate. After harvest, seeds from WS plants were collected to estimate the aflatoxin content, using the ELISA method (Enzyme linked immunosorbent assays).

The results showed that drought stress decreased pod yield (by 59%), harvest index (by 50%) and haulm yield (by 11%). Figure 1 shows the effects of drought on pods and haulm. Under drought conditions, we found

a significant genotypic variation for pod yield, which ranged from 88–233 g/m$^2$; aflatoxin contamination ranged from 1.1–692 parts per billion (ppb).

Table 1. Pod yield (g/m$^2$) and aflatoxin content (ppb) of high-yielding genotypes under drought-stress conditions

| Groundnut genotype | Pod yield (g/m$^2$) | Aflatoxin contamination (ppb) |
|---|---|---|
| ICG 11322 | 223 | 4.98 |
| ICG 1415 | 217 | 1.61 |
| ICG 13941 | 214 | 6.00 |
| ICG 3584 | 212 | 6.88 |
| ICG 2925 | 212 | 2.36 |
| ICG 111 | 206 | 4.99 |
| ICG 4412 | 205 | 4.35 |
| ICG 6813 | 199 | 3.34 |
| ICG 1973 | 193 | 4.66 |
| ICG 12921 | 187 | 2.27 |
| ICG 1569 | 187 | 3.48 |
| ICG 15415 | 186 | 6.20 |
| ICG 1519 | 183 | 6.44 |
| 55-437* | 194 | 11.50 |
| Fleur 11** | 160 | 115.06 |

* = tolerance check
** = type sensitive to drought and aflatoxin contamination

Among the 32 genotypes tested for aflatoxin contamination under drought conditions, thirteen were high yielding and had low aflatoxin concentration, genotype 55-437 used as check for tolerance to aflatoxin contamination and Fleur 11 as a sensitive variety. The result are shown in Table 1.

All the genotypes were less contaminated than 55-437 and were from the groundnut reference collection (a mini collection representing the ICRISAT groundnut collection). This suggests possible new sources of resistance to aflatoxin contamination from these genotypes. Among the traits contributing to this performance under water deficit, the partition rate was the only one that correlated ($r^2 = 0.32$) to aflatoxin content. However, this correlation is not that high; further research is needed to identify the traits associated with resistance to drought and aflatoxin contamination. Genotypes with these traits can then be used to breed improved varieties.

***Farid Waliyar, Hamidou Falalou***

2 Arunyanark A, Jogloy S, Wongkaew S, Akkasaeng C, Vorasoot N, Wright CC, Rao CN Rachaputi and Patanothai A. 2009. Association between aflatoxin contamination and drought tolerance traits in peanut. Field Crops Research, 114, 14–22.

3 Waliyar F, Traoré A, Fatondji D and Ntare BR. 2003. Effect of water deficit on aflatoxin contamination of peanut in sandy soil of Niger. Peanut Science. 30, 79–84.

# Using a pigeon pea border to regulate fruit worm on okra

Okra is a traditional vegetable crop in West Africa, and large areas are under cultivation. The crop has huge socio-economic potential, particularly in Niger.[4] It is particularly profitable for women.

For this reason, ICRISAT has collaborated since 2008 with partners[5] including, the Center for International Cooperation in Agronomic Research for Development (CIRAD) to evaluate two crops – pigeon pea and sorghum – as border-trap crops to regulate populations of, and damage caused by, the tomato fruit worm (*Helicoverpa armigera*) on okra. These crops attract the fruit worms, diverting them away from okra.

## Tests

In 2008, we used a randomized complete block design (RCBD) with four treatments: an unbordered, unsprayed control; pigeon pea as a border-trap crop; sorghum as a border trap crop; and an unbordered control crop sprayed with the insecticide cypermethrin. Each treatment was repeated twice (Figure 2).

We found that planting pigeon pea (short-cycled cv ICPL 87) as a border-trap crop reduced fruit worm infestation compared to the unbordered, unsprayed control and the sorghum-bordered unsprayed crop (Figure 3). This lower infestation significantly reduced

Figure 2. A view of the layout design of the trap-cropping experiment conducted at INRAN/Birni N'Konni in 2008

the damage to okra fruits. However, the fruit worm infestation was still higher than in the unbordered, cypermethrin-sprayed control crop.

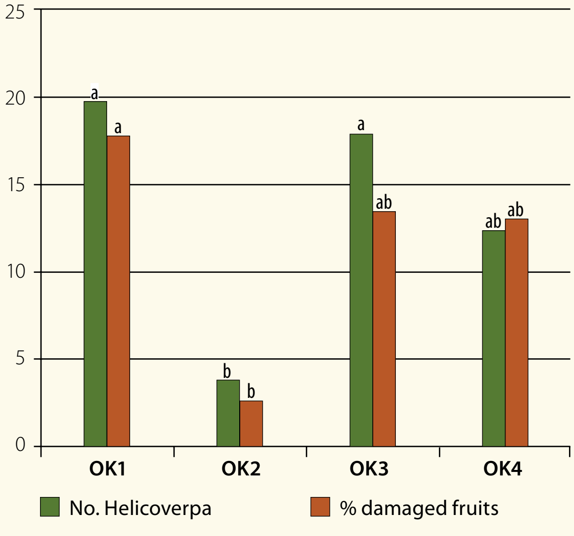
In 2010, the RCBD was modified to further test pigeon pea as a border-trap crop. We tested four treatments, with four replications: an unbordered, cypermethrin-sprayed control; an unsprayed control, and; two pigeon pea-bordered unsprayed treatments, with two pigeon pea cultivars (early ICPL 87 and extra-early ICPL 85010).

The okra fruit yield was significantly higher in plots bordered with the extra-early pigeon pea cultivar, compared with other plots. The vegetative development of the okra plants was also better; we ascribe this to nitrogen fixation by the pigeon pea border, as pigeon pea is a legume.

The nitrogen-rich okra plants attracted more piercing-sucking homopteran insect pests, particularly leaf-hoppers. But these do not significantly damage okra, because they are attracted at the vegetative stage, when the plant can overcome pest attack via physiological resistance due to better plant nutrition.

There was also a higher colonization of general pest predators, particularly spiders. These were notably high in okra plots bordered with the extra-early pigeon pea cultivar. Figure 4 shows these results. So the lower

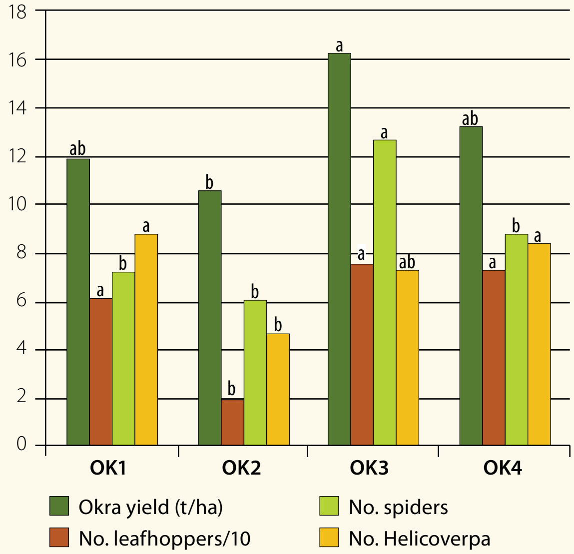
Figure 3. *Helicoverpa armigera* abundance (cumulated value of larvae per okra plant) and rate of okra damage by fruit worms according to treatments




Tests performed at INRAN/Birni N'Konni, 2008. Treatments with the same letter are not significantly different (Newman-Keuls method, P=0.05).

OK1= unbordered unsprayed control;
OK2 = unbordered cypermethrin-sprayed control;
OK3 = unsprayed sorghum-bordered (cv Sepon 82);
OK4 = unsprayed early pigeon pea-bordered (cv ICPL 87)

Figure 4. Okra (cv Konni) fresh fruit yield and infestation/colonization by arthropods at INRAN/Birni n'Konni in 2010




Tests performed at INRAN/Birni N'Konni, 2008. Values were cumulated from weekly visual records from six hill observation sub-plots. Treatments with the same letter are not significantly different (Newman-Keuls method, P=0.05).

OK1= unbordered unsprayed control;
OK2 = unbordered cypermethrin-sprayed control;
OK3 = unsprayed extra-early pigeon pea-bordered (cv ICPL 85010);
OK4 = unsprayed early pigeon pea-bordered (cv ICPL 87)

infestation of fruit worm on okra plots could be due to top-down regulation by generalist predators, in addition to the bottom-up effect of the border-trap crops.

The results question the relevance of using the trap-cropping 'pull' effect of the pigeon pea border alongside the 'push' effect of using insect-repellent sprays on okra. They also question the value of using a border trap crop for its barrier effect against piercing-sucking homopteran pests. But they do provide new insights into the benefits of controlling fruit worm via intercropping okra with a legume plant, which improves the amount of nitrogen available to the main crop and thus increases its attractiveness (and physiological resistance) to homoptera.

***Alain Ratnadass***

4 Kumar S, Dagnoko S, Haougui A, Ratnadass A, Pasternak D, Kouame C. 2010. Okra (*Abelmoschus* spp.) in West and Central Africa. Potential and progress on its improvement. African Journal of Agricultural Research 5:3590–3598.

5 Other partners include the World Vegetable Center (AVRDC), INRAN and the University of Niamey.

# Getting to know your parents

## Combining abilities of sorghum hybrid parents

The development of sorghum hybrids for WCA offers an important opportunity to achieve the number one priority of farmers and industry – increased grain yields. After a decade of collaborative research by the Insitut d'Economie Rurale (IER) and ICRISAT, the first series of hybrid parents based on locally adapted germplasm have been developed for the Sudanian zone of Mali and West Africa.

A diverse set of hybrid parents, both male-sterile seed parents and fertility-restoring male parents, were created. These included: inter-racial Guinea-Caudatum

Panicles of sorghum hybrid produced with male-parent 'Lata'

types, with grain and glume types intermediate between these races; Guinea-race population derivatives with more than 80% genetic background from Guinea-race materials; and landrace varieties of complete Guinea-race backgrounds. These hybrid parents differ in important agronomic traits such as maturity and plant height, offering considerable options for hybrid development.

### Testing the parents

It is helpful to know which parents warrant most attention for use in hybrid- and hybrid-parent development work. To answer this question we assessed the general combining ability (GCA) of each parent. This is determined for each individual parent by comparing the mean yield of all hybrids involving that parent with the mean of all hybrids in the test. A positive GCA value indicates an average superiority in hybrids involving that parent; a negative value indicates general inferiority of hybrids produced by that parent. This measure estimates the average breeding value of each parent.

IER and ICRISAT put together a set of five female parents and 11 male parents. These represented the range of maturity, plant height and genetic backgrounds of the parents currently developed for Mali's Sudanian zone. To test the average combining abilities of these materials, each female parent was crossed with each male parent, producing 55 hybrids. These were tested in seven trials in 2007 and 2008 at ICRISAT-Samanko's research station and the IER-Sotuba and IER-Cinzana experiment stations in Mali. Local and improved varieties were tested alongside the hybrids to compare productivity levels.

### Results

Analysis of the average GCA yield contribution of each male parent showed significant differences among parents (Table 2). Key results include:

- Three parents boosted yields by an average of over 30 g/m$^2$ (equivalent to 300 kg/ha) when analyzed over six southern Sudanian environments.
- The parents giving the highest yield advantages came from inter-racial Guinea-Caudatum and Guinea-race populations. These breeding populations were created by intercrossing local Guinea-race varieties with introduced Caudatum germplasm, and backcrossing to Guinea-race materials to retain desired grain, panicle and adaptive traits.

Table 2. GCA of male parents (average yield contribution to hybrids in g/m$^2$) in six trials in the Southern-Sudanian zone and one in the Northern-Sudanian zone of Mali

| | | Southern Sudanian Zone | | | | | | Northern Sudanian Zone |
|---|---|---|---|---|---|---|---|---|
| Type/ parent | Males | Samanko LowP'07 | Samanko LowP'08 | Sotuba'07 | Samanko HighP'08 | Sotuba'08 | Samanko HighP'07 | Cinzana'07 |
| Caudatum | MALISOR-92-1 | -14 | -19 | -15 | 51 | -26 | -1 | 21 |
| | 00-KO-F5DT-19 | 22 | 19 | -21 | 40 | 20 | -23 | 12 |
| Guinea-Caudatum | 02-SB-F4DT-298 | 12 | 31 | 45 | 12 | 76 | -13 | -20 |
| | 02-SB-F5DT-189 | -26 | -53 | -5 | -26 | -52 | -35 | -1 |
| | GRINKAN | 5 | 24 | 3 | 47 | 47 | 12 | -6 |
| Guinea Population | CGM-19/9-1-1 | -6 | 40 | 9 | -6 | 60 | 11 | -11 |
| | LATA 3 Bala | 34 | 32 | 72 | 21 | 34 | 30 | -25 |
| Guinea Landrace | CSM-388 | -5 | -9 | -26 | -66 | -55 | -2 | -22 |
| | CSM-63E | 4 | 0 | -26 | -14 | -18 | 28 | 32 |
| | IS 6731 | -8 | -38 | -16 | -44 | -38 | 1 | -2 |
| | SEGUETANA | -16 | -27 | -19 | -13 | -47 | -8 | 22 |
| | se* | 11 | 11 | 16 | 17 | 17 | 15 | 17 |

* se = standard error
Yellow boxes indicate positive GCA values that are more than double the standard error

Table 3. GCA of female parents (average yield contribution to hybrids in g/m$^2$) in the Southern- and Northern-Sudanian zones of Mali

| Type/ parent | Female | Southern Sudanian Zone | | | | | | Northern Sudanian Zone |
|---|---|---|---|---|---|---|---|---|
| | | Samanko LowP'07 | Samanko LowP'08 | Sotuba'07 | Samanko HighP'08 | Sotuba'08 | Samanko HighP'07 | Cinzana'07 |
| Guinea-Caudatum | 12A | -10 | -2 | -9 | -4 | -17 | -4 | 15 |
| | 150A | -5 | 4 | 23 | 55 | 36 | 3 | 17 |
| | PR3009A | -4 | -12 | -30 | -11 | -3 | 1 | 25 |
| Guinea Population | GPNA | -2 | -19 | 20 | -29 | -29 | -11 | -25 |
| Guinea Landrace | FambeA | 21 | 29 | -4 | -11 | 12 | 11 | -32 |
| | se* | 7 | 7 | 11 | 12 | 11 | 10 | 10 |

* se = standard error
Yellow boxes indicate positive GCA values that are more than double the standard error

- In contrast, the pure Guinea landrace parents gave average to low combining abilities in the southern Sudanian zone.
- In the drier northern-Sudanian environment, the only parent with a positive GCA was an early maturing Guinea landrace.[6]

The combining abilities of the female parents differed between the poor soil (low phosphorous) and the better fertilized environments (Table 3). Whereas the Guinea landrace parent produced hybrids with an average yield superiority of over 300 kg/ha in the poor soil fertility environments, an inter-racial Guinea-Caudatum female (150A) produced the best hybrids in the better fertilized environments. In the drier Northern Sudanian zone, yet another female, the early maturing PR 3009A, produced the best hybrids.

## Next steps

The superior hybrid parents identified in this study are being used extensively to produce further experimental hybrids. For example, the male parent 'Lata', identified as a high-combining ability line, is being used to produce four hybrids. These were tested in 31 on-farm participatory yield trials in 2009 and 2010. The mean yield of the four hybrids was 1,980 kg/ha, which was over a half ton (540 kg) higher than the well-adapted Guinea landrace check variety 'Tieble'. This average yield level represents a 37% yield advantage over a variety that is now widely being adopted in Mali.

The best of these four hybrids, Fadda (12A x Lata), had a mean yield of 2,150 kg/ha, a 49% yield increase over Tieble. Larger scale seed production and commercial marketing of this hybrid have now been initiated in Mali by COPROSEM, a cooperative of farmer seed producers, with IER and ICRISAT providing training in hybrid seed-production methods.

And the key lesson we have learned … it pays to know your parents!

*Fred Rattunde, Abdoulaye Diallo, Eva Weltzien*

6 CSM63E

# Producing hybrid sorghum seeds in Nigeria

There is little use of locally developed hybrids seeds in Nigeria, except for maize. Most seed companies market open-pollinated varieties (OPV) of most crops.

OPVs have limited yield potentials and farmers tend to recycle them, either to save costs or because improved-variety seeds for important food crops are not available. The quality of recycled seeds is low, as are the grain yields of the resulting crops. The returns to investments in seed production are also low, meaning little or no profit for investors. This threatens the sustainability of the seed companies and the seed system as a whole.

### Sorghum hybrids

Sorghum is currently cultivated in over 7 million ha in Nigeria – the largest area of any cereal – with an average grain yield of 1.5–2.0 tons/ha. With the growing demand for sorghum and its by-products, particularly from the food, malting and confectionary industries, there is a need to increase yields per unit area.

This will require high quality hybrid seeds of improved varieties, as well as inputs including fertilizers and pesticides and improved agronomic practices. To enable this, the ICRISAT–WASA Seeds Project initiated hybrid seed development programmes. Scientists received hybrid and parent germplasm lines of sorghum, as well as rice, maize, millet and vegetables with which to develop new hybrid seeds.

*A farmer shows of his hybrid seed production field*

### Training

The Seeds Project also organized a 5-day training programme in August 2010 to demonstrate the technology of hybrid sorghum seed production and increase the knowledge of breeders and seed scientists. The Institute for Agricultural Research (IAR), Ahmadu Bello University and Samaru-Zaria conducted the training.

A total of 72 participants from Burkina Faso, Ghana, Mali, Niger, Nigeria and Senegal took part. They came from national research institutes, seed companies, the National Agricultural Seeds Council, agricultural development programmes and non-governmental organizations (NGOs). They found the training very useful and relevant, to their research activities and their businesses.

To maintain and increase the production of hybrid sorghum seeds, in Nigeria in particular, the Seeds Project worked with IAR to evaluate several more hybrids. From these, four went into the second year of testing, both on-station and on-farm, in the 2010 cropping season. We expect two of these hybrids to be recommended for release at the next varietal release committee meeting.

***Hakeem Ajinde Ajeigbe***

# Maximizing micronutrient intake from sorghum

## The effects of grain decortication in Mali

The effects of micronutrient deficiency in humans include impaired physical and cognitive development, increased risk of morbidity and mortality in children, and reduced work capacity due to lack of energy. These conditions can have a significant impact on national development, especially in developing countries where a large part of the economic output is based on physical labor. It is essential to ensure that people's diets meet nutritional needs.

Micronutrient intake in several African countries is similar to Western countries but in rural Mali, both the intake and bioavailability[7] of micronutrients are low. An ICRISAT study showed that the iron (Fe) and zinc (Zn) intakes of young children in Mali only provide a third of their recommended daily allowance, and iron bioavailability is only 5%. The intakes of the pregnant women surveyed only provided half of their

iron requirement, and less than one-fifth of their zinc requirement.

It is unsurprising that an estimated 81% of children under 5 years, and almost 70% of women of reproductive age (and 76% of pregnant women) in Mali are anemic. These estimates are higher for children in rural areas (86%) than urban areas (69%). This is a particular issue in malaria-endemic countries like Mali, where hemolysis[8] from malaria infection is a major cause of anemia; about 50% anemia prevalence is attributed to iron deficiency.

## The importance of sorghum

Cereals contribute to more than half of women and children's iron and zinc intakes in Mali. Sorghum, the main cereal eaten in rural Mali, accounts for about 30% of these intakes from cereals. But sorghum contains phytate, a substance that reduces the bioavailability of iron and zinc by binding them into insoluble complexes in the physiological pH conditions of the small intestine. This reduces the amount of the nutrients people can absorb.

Food processing methods affect the nutrient composition and bioavailability of cereals. Decortication – removing the husk of the cereal – is the predominant processing method in rural Mali, typically carried out by pounding grains using a mortar and pestle. The grains are winnowed to remove the bran, washed and sun-dried, then pounded into flour for porridges and pastes.

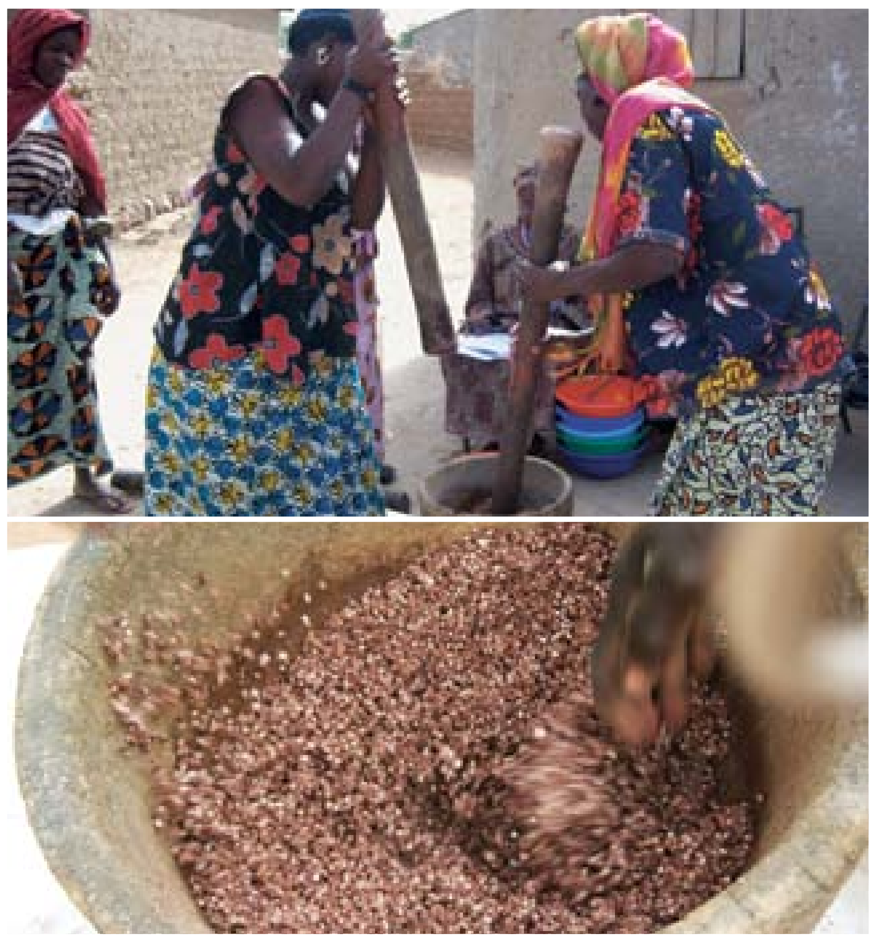
We assessed the effect of sorghum decortication on the content of iron, zinc and phytate, and bioavailability of iron and zinc, to guide work on nutrition and health. Five sorghum varieties (Djelefi, Dougouba, Tamia, Tiandougouba Coura, Tieble) were selected for the study. These varieties, which come from different agronomic backgrounds, are the ones preferred by farmers. The study was conducted in eight villages in southern Mali, where women routinely use decorticated sorghum to prepare food. In the test, the women determined when the grains were sufficiently decorticated. Samples of whole and decorticated grains were then analyzed for their iron, zinc and phytate content.

## Findings

The results showed that the iron content in the whole (non-decorticated) grain ranged from 31.6 to 37.9 parts per million (ppm); the zinc content ranged from 16.8 to 21.0 ppm; phytate ranged from 7,100 to 8,600 ppm.

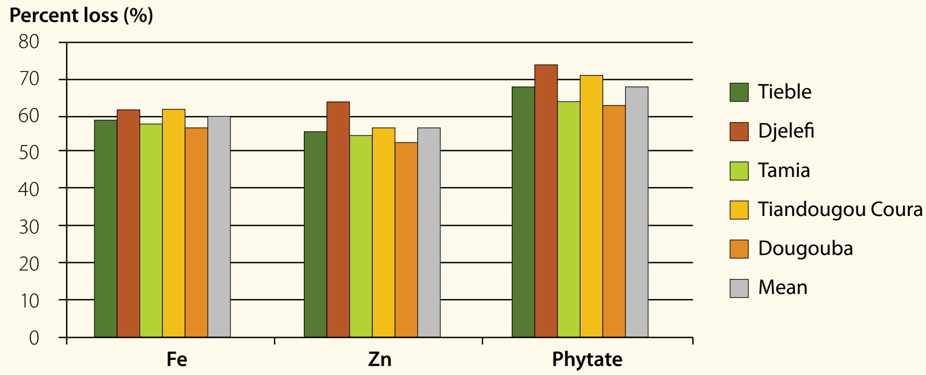
On average, decortication resulted in 30% grain loss, but this differed significantly between the varieties. Dougouba had the highest grain loss (35%) but lost the least iron, zinc and phytate through the process. Djelefi, the variety with the second lowest grain loss, had the highest nutrient losses. This suggests that there are differences in the distribution of these nutrients within the grains of the different sorghum types.

The differing rates of grain loss suggest differences such as grain size and hardness between varieties. In addition, grain loss varied from village to village. This could be due to differences in the evaluation of 'sufficiently decorticated grains', as this was determined by women from different villages.



*Traditional method of decortication using a mortar and pestle*

Figure 5. The effect of decortication on the iron, zinc and phytate content of five sorghum varieties




Overall, decortication led to a loss of more than half of the phytate content, and more than half of the already limited iron and zinc content (Figure 5). These losses are significant for a population who are largely dependent on sorghum. However, decortication actually increased the bioavailability of iron and zinc in all varieties, as it led to greater losses in phytate than in iron and zinc.

## Conclusions

Decortication might improve nutrient bioavailability and food quality, but it also drastically reduces the iron and zinc contents of grains. This makes it an unsuitable processing method for nutritionally vulnerable populations like those in rural Mali.

It is important to promote alternative food processing methods which improve food quality and nutrient retention, especially for children's nutrition. ICRISAT is currently exploring processing methods such as fermentation and malting – these break down phytates, increasing the bioavailability of iron and zinc – to complement other work on biofortification. Modifying people's food habits is not easy, though, and we will need to sensitize people to these new processing methods.

In the meantime, plant breeding efforts should focus on producing varieties with relatively higher iron and zinc contents, and lower phytate contents, and which retain much of the grain and nutrients after decortication.

*Vera lugutuah*

7 The bioavailability of a nutrient is the proportion of that nutrient in a food or meal that is utilized for normal body functions.

8 The breakage of the membrane of red blood cells, causing the release of the hemoglobin.

# Hitting the spot

## Success with fertilizer microdosing

Humans must be the most adaptable of all living creatures. We live in the coldest climates, the hottest climates, in lush green surroundings and the harshest driest tropics – and still survive!

But survival is not enough. We need quality in life; we need variety; we need sustainability. Poor soil fertility and low rainfall have affected crop production in the Sahel for decades. These problems cause food crises and food insecurity, which contribute to chronic malnutrition.

The average rate of fertilizer use in sub-Saharan Africa is low – a mere 8 kg/ha compared to a world

average of 100 kg/ha. Farmers have long been encouraged to use more fertilizer, but could not afford to do so. The cost of fertilizer at the village level is often more than three times as much as in the developed world, due to high transport and transaction costs. Low fertilizer use leads to low yields for most food crops – often less than 500 kg/ha in the dry areas. This keeps African farmers mired in poverty.

## Microdosing

But fertilizer microdosing is helping farmers to improve this discouraging situation. Microdosing is the strategic application of small doses of fertilizer in the hill of the plant at sowing, or at the base of the plant shortly after planting. This replaces the conventional method of spreading the fertilizer across the field. This precision placement helps the roots grow out more quickly,

### Microdosing in Burkina Faso

Allassane Anadaga lives in Tiébilé, in Nahouri province, Burkina Faso, and is the head of a family of 32 people. On his farm he grows 5 ha of corn, 5 ha of sorghum, 1 ha of cowpea, 2 ha of upland rice. He also has an area for cultivating maize in the rainy season, and potatoes and onions the rest of the year.

Having worked the land for many years, Allassane knows a lot about food security in Tiébilé. "Many households are experiencing difficult times due to the droughts that are common in our region; the flooding in the past three years has become recurrent and devastated many fields", he says.

However, Allassane's situation is much better than for some of his fellow farmers. He is a beneficiary of the Alliance for a Green Revolution in Africa (AGRA)'s microdosing project in Burkina Faso, which has run for two years in Tiébilé. Allassane was among the producers selected and trained by the Network, who implemented the project. He explains the process: "I was trained in microdose techniques, which involve the judicious use of fertilizers. I also received training on the warrantage system [an inventory credit system], which has facilitated my access to credit and the acquisition of farm inputs."

*Allassane Andaga in his field*

Since implementing the microdose technology and joining the warrantage system, Allassane's last two harvests have been successful. "2010 was for me the beginning of a process towards ending poverty," he says.

#### *The gateway to success*

To reach this stage, Allassane followed the correct microdosing methodology. First, he created a demonstration plot on 1 ha of maize. On this plot, he put into practice all his training.

Following this trial, he cultivated 2 ha of rice using the same method. The results are truly spectacular; compared to previous season, and on the same land, Allassane saved fertilizer and increased his crop productivity. Microdosing also increased his yields; he harvested 60 bags of rice paddy on 2 ha, compared to the maximum 12 bags he used to harvest per ha. His production increased from 15 to 25 bags per ha for maize in 2010.

Allassane is a success in his region. Producers from Tiébélé and farmers from other municipalities in the province have visited his corn and rice demonstration fields during tours organized by the AGRA microdose project. After starting with rice and corn, Allassane now uses the microdosing technique on his potatoes. He is also researching how to combine organic manure and chemical fertilizer at transplanting – an integrated soil fertility management technique for better and faster crop productivity.

"Thanks again to AGRA for bringing microdosing technology to us. I got a loan through the inventory credit system that allowed me to pay for labor to increase my production. I want this project to reach the maximum number of places in Burkina Faso" concluded Allassane.

capture more native (non-added) nutrients and find water. Combined, these effects significantly increase the agronomic and economic efficiency of nutrient and water use, raising crop yields.

Microdosing is adoptable and profitable. By using smaller amounts in more efficient ways means farmers are much more inclined to adopt the practice.

ICRISAT and its partners – NARS, universities, NGOs and farmers' organizations – have worked for years to develop microdosing technology. This work includes the TARGET microdosing project, the West and Central African Council for Agricultural Research and Development (CORAF)–African Development Bank microdosing project, and currently the AGRA microdosing project.

The AGRA–ICRISAT project started in June 2009 in Burkina Faso, Niger and Mali. Its aims are to increase the production of millet, sorghum, cowpea and maize by 50%, and increase farm incomes by 30% for at least 130,000 farm households. The technology has been widely disseminated and adopted. This has lead to many success stories.

***Mahamadou Gandah, Idriaas Ouedraogo***

# Fast-tracking the release of new groundnut varieties through farmer participatory variety testing

*Women in Bougoula, Mali, are happy with the new groundnut varieties*

During the last 40 years, donors and governments have invested more than $200 million in seed production, variety development and distribution projects in Mali, Niger, Nigeria and Senegal. Through this investment, ICRISAT and its partners have developed and adapted 39 groundnut varieties – both single and multiple-purpose. But only 10 varieties have been released. Between 2002 and 2009, no new groundnut varieties were released in Senegal or Nigeria, the largest groundnut-producing countries in West Africa.

National Variety Release Committees (NVRCs) decide whether to release or reject a new seed variety, based on data compiled in a release proposal. But NVRCs across the region are either missing, not functioning or meet too irregularly. Variety release procedures are often complex and costly, as in Senegal, or non-existent, as in Niger. The process is also duplicative, as each variety must be tested in all countries where it is being marketed.

The difficulties with existing variety release systems have delayed farmers' access to new groundnut varieties. Seed companies' returns on their investment in developing new varieties are also delayed, as they have to wait a long time before they can enter the seed market.

## Fast-tracking

To overcome these constraints, ICRISAT initiated a programme of farmer participatory variety evaluation in 2008. Working in Mali, Niger and Nigeria, the objective was to enable farmers to start using new, more

productive varieties, replacing the current varieties which were introduced over 50 years ago.

After two years of farmer participatory variety testing, followed by large on-farm demonstration plots in 2010, new groundnut varieties were finally approved.

- The National Agricultural Research Programme (NARP) in Niger registered four varieties[9] in the national catalogue; prior to this, the last registration of varieties was in 1994.
- Mali's NARP has recommended four new varieties[10] for release in 2011 – the first since 2001.
- Farmers are already growing these new varieties, exchanging seeds and selling them at local markets.
- Three early-maturing varieties that are resistant to rosette (a destructive virus disease) are near release in Nigeria; these will be the first new releases since 2001.

This fast-tracking process provides several lessons for speeding up other registration processes:

- ***Use data from other countries.*** Testing should not be mandatory for varieties already released in other countries, if the recommendation domain is the same.
- ***Simplify variety testing.*** Farmer participatory variety selection should be institutionalized and recognized as a key step in reducing the time taken for varietal releases.
- ***Promote breeders' own data.*** This can eliminate the need for national performance trials. The number of locations required for release should be small, with an emphasis on locations where the variety will be recommended for release.
- ***Use breeders' seeds.*** Breeders should embark on limited seed production and marketing instead of waiting until a variety is fully released, as this prolongs the time taken for the variety to reach farmers.
- ***Develop variety-release guidelines.*** Some NVRCs reject a variety and ask the breeder to improve a specific trait, delaying its release. But releases should be based on uniqueness; the new variety should contribute new farmer- or market-preferred traits that existing varieties do not possess. Governments should develop variety release guidelines where they are lacking to ensure a fair and transparent variety release process.
- ***Increase the frequency of meetings.*** These meetings are currently irregular but resources should be made available to improve this.

***Bonny Ntare***

9 RRB, J11, ICG 934 and Fleur 11
10 ICGV 86015, ICGV 86124 ICGV-IS 96802 and ICGV 93525

# Let's talk money!

## Integrated *Striga* and soil fertility management for sorghum and pearl millet

For five years, ICRISAT and partners have conducted farmer field schools in Mali, Niger and Nigeria to develop practical and affordable methods of integrated *Striga* and soil fertility management (ISSFM). *Striga* are parasitic plants that can devastate crops such as sorghum and pearl millet.

With the field school participants, we developed a cropping calendar and protocol for the dominant farmer practice (FP) in the villages. After discussing local options for *Striga* control and increasing soil fertility, and amending these with any relevant research findings, the groups then developed an ISSFM practice. This consisted of intercropping the cereal crop with a legume (such as cowpea or groundnut), applying organic and mineral fertilizers, introducing crop management practices (such as ridging or hand-pulling *Striga* when it flowers) and sometimes growing a cereal variety that is resistant to *Striga*, such as the Seguetana or Soumalemba sorghum varieties.

During the season, we tested the dominant local FP against ISSFM on large plots. Farmers monitored the

### How we organize farmer field schools

Setting up the farmer field schools follows a standard process. In the early stages, we hold village meetings at which farmers (both women and men), technicians and scientists get to know each other and exchange information about local agriculture. If *Striga* and soil fertility come up as issues affecting the village, we organize focus group discussions to quantify or map the occurrence in the village, and the possible causes.

Further exchanges then take place to determine local knowledge about *Striga* and soil fertility, and what farmers are doing about these problems. This creates a common understanding which forms the basis for further activities, such as a farmer field school around the topic of Striga and soil fertility.

During further preparatory meetings, the village chooses participants for the field school. Together we identify an experimental field and determine the rules and responsibilities for partners.

*Lead farmers explain the cost and benefits of FP and ISSFM in Segou region, Mali, 2008*


*A field agent guides the preference-ranking process of control-option technologies in Koulikoro region, Mali, 2010*

crops, the occurrence of *Striga*, the general environment, and other biotic constraints such as insects, weeds and crop diseases. They also learnt about crop development, soil fertility and fertilizers, and *Striga* biology and control, during training and discussions with technicians, scientists and other farmers. After the trial was complete, the plots were harvested, threshed and weighed.

### Talking money

The testing from the farmer field schools often produced interesting results. They usually showed that ISSFM significantly reduces the *Striga* population, improves crop productivity and improves soil fertility in the long term. But the farmers always ask: "Can we make money from ISSFM?"

Comparing the costs, revenues and profits of the two practices has become an essential part of the comparison of FP and ISSFM. The economical analysis proposed to farmers by ICRISAT and partners is a simplified version of what economists call 'partial budget analysis'. Performing this economic analysis gives farmers

*Harvested millet heads and groundnut pods and haulms from the ISSFM plot in Youre village, Mopti region, Mali, in 2009*

the right information and capacity to choose which technologies to adopt in their own fields.

The first phase is to compare the yields of the FP and ISSFM plots by weighing the grains and counting the number of stalk and haulm bundles harvested. The second phase consists of listing the different activities involved in FP and ISSFM and totaling the labor requirement (counted in working days). The additional labor time required for ISSFM compared to FP is a cost for the ISSFM practice.

During the third phase, the costs of seeds, fertilizers and other investments are combined and then deducted from the revenues (units of harvested products multiplied by their current market price per unit). This gives the profit for each practice and farmers can make an informed comparison of the two practices, comparing the investments, revenues and their resulting profits. This always leads to lively discussions! The final stage consists of citing the advantages and disadvantages of the separate technologies used in the ISSFM practice, followed by a preference ranking of these.

## Lessons learnt

Our research has produced several interesting findings. For example, changing from a pearl millet or sorghum pure crop to intercropping with legumes at high densities increases profits significantly, because cowpea and groundnut haulms get high prices as animal feed. It is also interesting to note that farmers in different parts of Mali have different responses to the ISSFM components.

- Farmers in the north, who grow mainly pearl millet, prefer technologies such organic fertilizer, intercropping cereals with legumes and hand-pulling Striga at flowering. These do not require a direct cash investment, unlike mineral fertilizer.
- For farmers in the south, who grow more sorghum, there are Striga-resistant varieties but labor availability is a constraint. These farmers favor varietal resistance, while labor-intensive techniques – especially pulling Striga by hand at flowering – rank lower as control options.

A key finding is that ISSFM requires more financial investment and a bit more labor than FP, but almost always leads to higher profits. Performing the economic analysis with farmers provides them with the right information and capacity to choose which technologies to adopt in their own fields, making a difference to their food security and incomes.

***Tom Van Mourik***

# Science with a human face

## An outstanding partnership between Fuma Gaskiya, INRAN and ICRISAT-Niger

The partnership between ICRISAT-Niger, INRAN and the farmers' organization Fuma Gaskiya won ICRISAT's prestigious 'Outstanding Partnership Award' in 2010. Fuma Gaskiya was further recognized by ICRISAT as the 'Outstanding Partner' for 2010. The partnership is a vital example of 'science with a human face' – science that has a direct impact on local people while creating international public goods.

### Fuma Gaskiya

Created in 2002 and based in Niger's Maradi region, Fuma Gaskiya currently comprises 17 unions with 325 subgroups, and 52% of its 9,327 members are women. The organization is led by the president, Abdou Wakasso, who is a farmer, and the executive director, Ali Mamane Aminou, who holds a BSc in agriculture.

ICRISAT laid the foundations for this partnership through the project 'Improved livelihoods in the Sahel through the development and implementation of household level bio-economic decision support systems (2003–2008)'. This was funded by the Belgian Directorate General for Development Cooperation.

During the last five years, ICRISAT-Niger and INRAN have cooperated with Doubara, the Fuma Gaskiya union. This union has 656 members (59% of whom are women) and is based in Serkinhaoussa village, Niger. This cooperation has focused on four major projects:

- The participatory sorghum and pearl millet improvement project (Phase I, 2006–2009), funded by the McKnight Foundation: this targets the development of cultivars with specific adaptation to farmers' needs.
- The seed systems project (Phase I, 2006–2009), also funded by the McKnight Foundation: this targets the development of local seed systems.
- The Community management of crop diversity to enhance resilience, yield stability and income generation in changing West African climates (CODE-WA) project (2008–2010), funded by the German Federal Ministry for Economic Cooperation and Development: this targets system diversification for better adaptation to climate variability and change, as well as research on communication for technology transfer.
- The Harnessing Opportunities for Productivity Enhancement (HOPE) project (2009–2013), funded by the Bill and Melinda Gates Foundation: this aims to develop the pearl millet value chain, disseminate new varieties, and integrate genetic and natural resource management techniques.

### Strengths

Important features of the partnership include participatory decision-making and gender equality: both women and men are explicitly targeted. It is also a supportive partnership: ICRISAT and INRAN give technical and financial support to Fuma Gaskiya, who in turn support the partners' research.

The partnership addresses various farmer-defined themes, including system diversification options, value-chain development and climate change adaptation. It

*Abdou Wakasso, president of Fuma Gaskiya, and Ali Aminou, executive secretary, examine the Sosat-C88 seed production field at Serkinhaoussa, Mali*

is also complementary: on-farm work implemented by Fuma Gaskiya is combined with on-station breeding and research activities at INRAN and ICRISAT.

The partnership focuses on impacts: all research is accompanied by farmer training to enhance the adoption of promising results. And the partnership produces international public goods via strategic methodology development and validation.

## Meeting CGIAR's goals

The partnership has contributed to the goals of the CGIAR in several ways. For example, as part of the McKnight project, two new farmer-preferred experimental pearl millet cultivars were developed (one was selected by women). Using a dynamic genepool management approach, multi-location trials in 2009 and 2010 showed that these new cultivars were adaptable beyond their selection site. This demonstrated the potential for a wider regional impact in Niger and neighboring Nigeria; all CGIAR centers aim to produce international public goods, such as crop varieties, that can adapt beyond their selection sites.

ICRISAT also trained seed producers from Fuma Gaskiya in the production and marketing of seeds of three pearl millet cultivars (ICMV IS 99001, ICMV IS 89305, Sosat-C88) developed by ICRISAT. The result was 10.4 tons of quality-declared or certified seed – equivalent to the total seed quantity of the 2008 and 2009 rainy seasons. This created income-generating opportunities for seed producers, enhanced farmers' access to ICRISAT pearl millet cultivars, and helped us to increase the area in which our pearl millet cultivars are grown in West Africa. This was also part of the McKnight project, and is currently being extended under the HOPE project.

The partnership is building capacity at international levels. Facilitated by exchange visits organized by ICRISAT, Fuma Gaskiya contributed to training less-developed farmers' organizations outside Niger, such as Union des Agriculteurs de Cercle de Tominian in Mali, Union Départementale des Producteurs de Nobéré in Burkina Faso, and the Kamwinsonthe women's group in Ghana. This farmer-to-farmer learning, promoted within the CODE-WA project, has proved an efficient way to transfer technology and know-how.

*Members of the Fuma Gaskiya women's group with ICRISAT scientist Bettina Haussmann at Serkinhaoussa*

Other accomplishments include:

- the introduction of systems diversification options comprising 12 different crop species for higher resilience in variable climates
- the identification of suitable off-season crops and the installation of off-season gardening activities at Serkinhaoussa, targeting rural women
- the establishment of Radio Binta, a community radio station at Serkinhaoussa, for information and knowledge exchange, technology transfer and research on communication for technology dissemination.

***Bettina Haussmann***

# The CGIAR research programme on Climate Change, Agriculture and Food Security

The Climate Change, Agriculture and Food Security (CCAFS) programme is a strategic 10-year partnership to help the developing world overcome the threats posed by a changing climate, by achieving food security, enhancing livelihoods and improving environmental management.

The CCAFS programme emerged from a new collaboration between CGIAR and the Earth System Science Partnership. It brings together the world's best strategic research in the fields of agricultural science, development, climate science and earth systems science to identify and address the most important interactions, synergies and tradeoffs between climate change, agriculture and food security.

As a collective effort, the CCAFS will become a hub that facilitates action across multiple CGIAR centers and research programmes. It will also involve farmers, policy makers, donors and other stakeholders; their knowledge and needs will be integrated into the tools and approaches that the programme develops.

ICRISAT-WCA is hosting Dr Robert Zougmoré, the CCAFS's regional programme leader for West Africa, who has been in his post since November 2010. Before this (starting in February 2010), Dr Noel Beninati acted as the interim regional facilitator, coordinating the implementation of CCAFS's 2010 work plan.

ICRISAT's support to CCAFS – from the regional director, scientific and management staff, and the director of the Resilient Dryland Systems programme – has led to several partnerships already. Organizations including the African Centre of Meteorological Application for Development (ACMAD), the Centre Régional de Formation et d'Application en Agro météorologie et Hydrologie Opérationnelle (AGRHYMET), the West and Central African Council for Agricultural Research and Development (CORAF), the Institut du Sahel (INSAH) and National Agricultural Research System (NARS) are involved in the CCAFS programme, which provided sub-grant agreements to implement activities in 2010.

## Place-based research

One of CCAFS overarching objectives is to assess and test pro-poor adaptation and mitigation practices, technologies and policies for food systems, adaptive capacity and rural livelihoods. This will be carried out through adaptive 'placed-based' research, structured around three themes: adaptation to progressive climate change; adaptation through risk management and; pro-poor mitigation. This research aims to decrease the vulnerability of rural communities and enable them to prosper under a variable and changing climate.

A fourth theme – integration for decision making – will ensure effective engagement with rural communities and institutional and policy stakeholders. This theme will make the programme demand driven and provide locally relevant analyses and tools for living in future climates.

Current outputs from CCAFS research studies focus on:

- the vulnerability of agriculture to climate change in 11 countries
- delivering models for climate information in West Africa
- establishing baseline greenhouse gas emissions from the agricultural sector
- mitigation potential in West African countries.

# At the Centers: ICRISAT activities 2010

## ICRISAT re-opens its Kano office in Nigeria

ICRISAT has re-opened its office in Kano, Nigeria, housed in the Agricultural Research Station, Institutes of Agricultural Research. The catalyst was a memorandum of understanding between ICRISAT and the Agricultural Research Council of Nigeria, signed in September 2008. In December 2010, Dr Hakeem A Ajeigbe, a principal scientist, was appointed as the country representative to be based at Kano.

One activity at Kano is the WASA Project. This project is developing a sustainable public–private partnership in the seed sector by addressing the problems of marketing and certifying seeds through rural agro-dealer linkages and networks. This will make high quality seeds available to farmers. The project started in 2008 and is funded by the United States Agency for International Development (USAID).

From the Kano office, ICRISAT will develop close links and cooperate with national, regional and international research institutions working in the country, as well as development agencies working on its mandate crops. For example, ICRISAT is using bilateral agreements and funds to enable institutes to participate in some of the HOPE projects. These include IAR, the Lake Chad Research Institute and the Community Based Agricultural and Rural Development Project, run by the International Fund for Agricultural Development (IFAD). We also support several Nigerian agricultural research institutes with their programmes to introduce hybrid seed development in rice, maize, sorghum, millet and vegetables.

## Visits and on-station activities

### *Chinese ambassador visits ICRISAT-Niamey*

29 April

The Ambassador of the People's Republic of China in Niger, His Excellency Xia Huang, visited ICRISAT's Sadoré research station on. In his welcoming words, Dr Farid Waliyar reminded those present of the close relations between China and the CGIAR, recalling his association with China and the various conferences he had attended there.

*His Excellency Xia Huang, the Chinese ambassador to Niger, and Dr Farid Waliyar at the Sadoré research station*

Ambassador Xia Huang showed particular interest in ICRISAT's genebank, nursery, Jatropha plantation and vegetable breeding project, as well as the school garden close to the research station. He shared his observations with Dr Waliyar on ICRISAT in general and ICRISAT-WCA in particular, emphasizing that his knowledge about ICRISAT has made him reflect on how to integrate the institution's major work with China's future activities in Niger.

### *Field day, Niamey* 6–7 October

ICRISAT-Niamey organized an open field day at the Sadoré research station in Niamey, together with its main partners in Niger: AVRDC, CIRAD, INRAN, the Institut de recherche pour le développement, the Japan International Research

Center for Agricultural Sciences (JIRCAS), the World Agroforestry Center (ICRAF) and the Tropical Soil Biology and Fertility Institute. The theme was 'Agricultural research results for better food security in Niger'.

A high-level official delegation participated in the opening ceremony, including Mr Malick Sadelher, the minister of agriculture and livestock in Niger, Colonel Soumana Djibo, the governor of the region of Niamey, and delegates from INRAN. About 350 participants were guided through the research fields inside the station and in Sadoré village. They visited the participatory experiment on the bioreclamation of degraded lands (BDL) and the Sadoré women's commercial nursery, both of which are promoted by ICRISAT. Other highlights included discussions with the researchers, a visit to the germplasm bank, and the exhibition stands.

### *Gates Foundation programme officer visits the HOPE project in WCA* 10–15 October

The Harnessing Opportunities for Productivity Enhancement (HOPE) project team in West and Central Africa hosted Dr Yilma Kebede, a programme officer for the Bill & Melinda Gates Foundation. Dr Kebede visited ICRISAT in Mali and Niger to understand the progress and constraints of the project in West Africa. The HOPE project, which is funded by the Gates Foundation, is in its second year of operation. Dr Kebede was accompanied by Dr Farid Waliyar, Dr Said Silim, regional director for ICRISAT-Eastern and Southern Africa and principal investigator of the HOPE Project, and Dr George Okwach, the HOPE project manager.

### *India's Ambassador visits ICRISAT* 20 October

India's first Ambassador to Niger, His Excellency YP Singh, visited ICRISAT-Niamey and met with Dr Farid Waliyar and the ICRISAT scientists Jupiter Ndjeunga, Albert Nikiema, S Kumar and David Pasternak.

At the outset, Mr Singh expressed his great appreciation for ICRISAT, having heard about the institute while interacting with different ministries in Niger. Dr Waliyar assured him that ICRISAT would help to identify the best interventions for agricultural development in Niger, so that the Indian Government could help the country.

Mr Singh planted a tree at the Sadoré station and was taken around some of the experimental fields of millet and groundnut breeding. He also visited the BDL fields, operated by the Sadoré women's association.

Mr Singh acknowledged ICRISAT's role in enhancing food security in Niger through technologies and endeavor. "ICRISAT is playing an important role in bringing India and Niger close in the field of agriculture," he said. Dr Waliyar will follow up with Mr Singh on further collaboration between India and Niger.

### *INRAN's director general visits ICRISAT-Niamey*

29 October

Dr Abdoulaye Mohamed started his visit to our Sadoré Centre, Niger by planting a tree at ICRISAT friends' garden. Accompanied by Dr Farid Waliyar, he was taken on a tour of the crop diversification and tree dissemination plot and the nursery. He later visited the Sadoré genebank to see the plant material and germplasm collections.

ICRISAT and INRAN have been key partners for many decades, working together on agricultural research into millet, sorghum, groundnut, diversification programmes and microdosing.

### *ICRISAT Niger celebrates Science Week*

24–27 November

Science Week, first initiated in 2009 by the French Embassy and the Niger Ministry of Secondary and Higher Education, Research and Technology, has become an important date in Niger's calendar.

*A visitor reads a document at the ICRISAT stall at the Scientifique Village of Niamey, Niger, November 2010*

On 26 November, ICRISAT hosted a video conference about biodiversity at Moumouni University of Niamey. The conference, co-organized with CIRAD, Ile de la Reunion and Moumouni University of Niamey, was attended by a large gathering of students, professors and scientists from ICRISAT and other agricultural research institutes. On 27 November, ICRISAT held an exhibition at the Village Scientifique (French for 'scientific village'), with posters and materials on agricultural research and crops including pearl millet, sorghum and groundnut. Throughout the day, ICRISAT scientists and technicians, led by Dr Waliyar, interacted with visitors to the Village Scientifique.

### *ICRISAT-WCA celebrates its Annual Day*

13 and 15 December

ICRISAT-Niamey celebrated its 38th anniversary on 15 December. This year's celebrations were unique – you could call it a dual celebration!

The first part took place at the ICRISAT Sahelian Training Center in Niamey, where a grand ceremony of appointment of houses took place. Most of the rooms were named after countries in WCA, while the conference room was named 'Nairobi' and the apartment named 'Patancheru', to mark the importance of the relationships between Nairobi, where ICRISAT's East and Central Africa hub is based, and Patencheru, where ICRISAT's Indian headquarters are based.

Among the dignitaries present were the ambassadors of Benin, Chad, India and Mali, the director generals of the African Centre of Meteorological Application for Development (ACMAD) and INRAN, and representatives of the Centre Régional de Formation et d'Application en Agro météorologie et Hydrologie Opérationnelle (AGRHYMET) and the Faculty of Agronomy. The second part of the celebration was a feast in Sadoré. In his address, Dr Waliyar spoke about ICRISAT's achievements and change in perspective for the period 2010–2020.

In Mali, ICRISAT-Bamako celebrated its Annual Day on 13 December. The event took place at a Malian camping site amid lush greenery. The chief guest was Dr Bino Teme, director general of IER, who reiterated his organization's support to ICRISAT in its mission. Other guests included the director general of the Institut du Sahel (INSAH) and the coordinators of the host institutions, AVRDC, the International Livestock Research Institute and ICRAF.

*Loyalty awards to ICRISAT staff during its annual day celebration*

### Farid Waliyar honored in Mali

The Malian Minister of Agriculture, Agathan Ag Alhassane, awarded Dr Farid Waliyar, regional director of ICRISAT-WCA, with a diploma in recognition of his contribution to Mali's agricultural development. Dr Waliyar received the recognition on 29 November 2010, the 50th anniversary of both Mali's independence and IER, one of ICRISAT's main partners in Mali.

The certificate reads: "This certificate is awarded at the fiftieth anniversary of Malian agriculture to Dr Farid Waliyar in recognition of his valuable contribution to agricultural development in Mali."


# ICRISAT promotes computer literacy in West Africa

ICRISAT-WCA distributed computers in West Africa throughout 2010, mostly to partner organizations. This initiative is part of a global project launched by Computer Aid International, based in the United Kingdom (UK), which aims to help developing countries acquire computing equipment for their development activities.

The principle is simple: Computer Aid receives second-hand computers from companies and private people who no longer need them. These are then sold to organizations that usually cannot afford to buy new computers. The second-hand computers are sold on a 'no profit, no loss' basis. In West Africa, the project was carried out by ICRISAT, ACMAD and Roger D Stern, a professor from the University of Reading, UK.

On 3 June 2010, two computers were handed over to a school in a village close to ICRISAT's hub in Sadoré, Niger. The school's director and teachers, the village chief, children's parents, the inspector for primary education in Say town, and of course the children, all attended the handover. Dr Farid Waliyar, ICRISAT's regional director for WCA, underlined the importance of computers in children's education. "For the young generation, computers need to become self-evident and normal, even in the most remote villages," he said.

ACMAD and ICRISAT have distributed over 220 computers to partner organizations and villages in several countries. The project will continue in 2011, with a new delivery of second-hand computers expected soon.

*Dr Farid Waliyar meets children at a school in Say town (nearby Niamey in Niger) during a computer handover ceremony*

# Satellite imagery for smallholder farmers in Mali


*Smallholder in Mali, using satellite imagery to get accurate information about his soil fertility and the size of his land*

*Dr Kofi Anan, Former UN Secretary General, co-recipient of the Nobel Prize and Board Chair of AGRA visit SIBWA on 30 August with Mali Prime Minister Modibo Sidibe. Here they talk with ICRISAT Scientist Pierre C.Sibiry Traore*

The 'Seeing is Believing West Africa' (SIBWA) believes that the fruitful exchange of knowledge is a two-way street. "From the roots, from the stars, scaling up and out," say the SIBWA team. The project uses very high resolution satellite imagery (VHRI) to give farmers in West Africa accurate information about their soil fertility and the size of their land.

The project is housed in Sotuba-GIS and managed by ICRISAT in Bamako, Mali, and it has support from some notable names. Mamadow Simpara and Sounkoutoun Sissoko, members of parliament from the Banamba and Diema districts of Mali. They championed VHRI for smallholders during last year's October session in the Malian Parliament. Others also support the project; Lassi Dembélé, counselor to the mayor of Sukumba, catalyzed village assemblies to learn about the use of VHRI as a discussion support tool. And Mamadou Doumbia, head of the soil-water-plant laboratory at IER, has promoted the Sotuba-GIS adventure in IER since 2000.

Kofi Annan, former United Nations secretary-general, co-recipient of the Nobel Peace Prize, and board chair of AGRA, visited SIBWA on 30 August 2010. He was accompanied by important leaders such as Modibo Sidibé, prime minister of Mali, Agathane Ag Alassane, Mali's minister of agriculture, and Tiémoko Sangaré, minister of environment. SIBWA gave them a glimpse of ICRISAT's vision for using VHRI in West and Central Africa.

SIBWA won the prize for the overall best presentation and project at the Africa Agriculture Geospatial Week, held in Nairobi, Kenya, from 6 to 12 June. SIBWA is funded by the Bill & Melinda Gates Foundation through AGCommons, with supplementary funding from USAID and the German Federal Ministry for Economic Cooperation and Development through the CODE-WA project.

***Pierre CS Traoré***

# Who we are

## List of scientific staff

### NIAMEY, NIGER


**Farid Waliyar**
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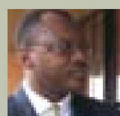
**Jupiter Ndjeunga**
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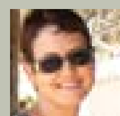
**Bettina Haussmann**
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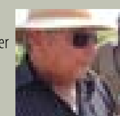
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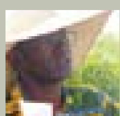
**Fatondji Dougbedji**
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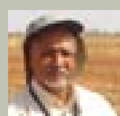
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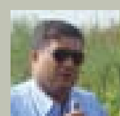
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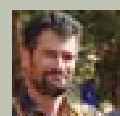
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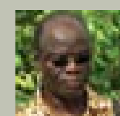
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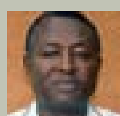
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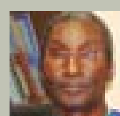
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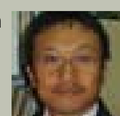
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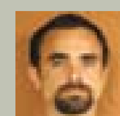
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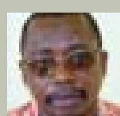
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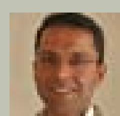
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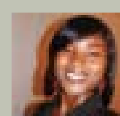
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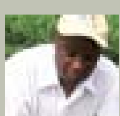
### BAMAKO, MALI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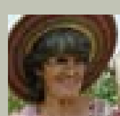
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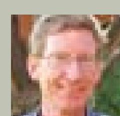
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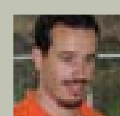
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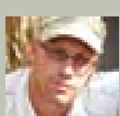
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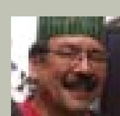
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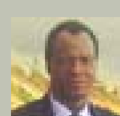
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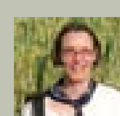
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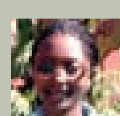
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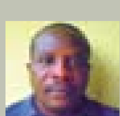
### KANO, NIGERIA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