Partnerships for resilient agriculture

Ways forward

ICRISAT West and Central Africa
2012 Highlights
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 near Hyderabad, Andhra Pradesh, India, with two regional hubs and four country offices in sub-Saharan Africa. ICRISAT is a member of the CGIAR Consortium.

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Foreword

A key message to sum up 2012 is that of gratitude and appreciation to all our partners and collaborators. Our partners have for the last 40 years worked with us and enabled us to live up to our dictum of science with a human face. We are proud to have worked alongside the poorest farmers in the semi-arid tropics of West and Central Africa and shared this science and its benefits with them.

This report presents our achievements in the year 2012. We have built on successes and experiences of previous years and carried out various activities that contribute directly to the CGIAR Strategic Level Outcomes (SLOs) through the CGIAR Research Programs to which ICRISAT WCA is contributing. The thrust of our contributions within each CGIAR Research Program is to provide strategic direction aligned to national and regional priorities and work with our partners to tackle research for Development (R4D) challenges within our framework Strategy of Inclusive Market-Oriented Development (IMOD) approach for smallholder farmers in the drylands.

In light of the emerging challenges being faced by farmers, particularly climate change, our research in 2012 focused on climate change mitigation and adaptation. Fortunately, much of the previous work and investigations related to development and releases of varieties that are resistant to drought remain very relevant. But rather than introducing ready-made solutions, ICRISAT Scientists have focused on exploring and working through participatory approaches that enhance understanding of the perceptions of producers, particularly with regards to climate change, to help in finding suitable alternatives linked with markets that will meet their current and future needs.

The report also reviews how our systems approach is adding value towards increasing the productivity and intensification of our mandate crops. Key examples in southern Mali, Niger and in Nigeria are presented. As always, partnerships remain the backbone of our interventions: partnerships with farmers and farmers’ organizations and associations, with national agricultural research institutions, and with the private sector and development partners.

Use, outcomes and resulting impact from our technologies remains important to us. In this report we review as an example, the use of fertilizer by micro-dosing. We see that micro-dosing has been successful and has incontestably impacted adoptive smallholders’ livelihoods in recent years. As we move forward, ICRISAT is exploring ways of ensuring the long-term sustainability of the technology and how to extend the benefits of such technology to a majority of small farmers.

Thus, this report highlights three major components: firstly, it explores ways of reducing vulnerability of the rural poor in the drylands of Sub Saharan Africa to drought and climate change for which results are presented on the sustainability of technologies and varieties resistant to drought in the Sahel zone. Climate services are also being developed and promoted.
to support decision making by farmers facing challenging climate conditions.

Secondly, considerable effort has been placed on development of a value-chain approach within the context of sustainable agriculture and an innovation systems approach in the region. This work fits well within our Inclusive Market-Oriented Development (IMOD) approach.

Thirdly, but certainly not least, we emphasize the role and importance of partnerships in research. Specific examples of our work on developing and disseminating pearl millet, sorghum and groundnut varieties are shared. We hope, you will enjoy reading this report and we look forward to more successes and greater impacts in the years ahead.
Integrated management technologies for aflatoxin in groundnut transferred to farmers in Niger and Mali

The threat to humans and animals from groundnuts contaminated with aflatoxins is being reduced by a combination of preventive measures. Not only can aflatoxins cause serious cancer and liver damage in humans, they can also affect poultry and livestock production. However, a series of integrated management technologies can significantly diminish the hazard of aflatoxin contamination and give farmers more consumable and saleable crops.

Among technologies for integrated management of aflatoxin in groundnuts developed by ICRISAT and its partners are:

- Groundnut varieties resistant/tolerant to aflatoxin;
- Protocols for seed treatment with a fungicide/insecticide;
- Application of manure/compost or gypsum at specific doses;
- Harvesting approaches for mature plants, including: shaking plants during harvesting to remove soil adhering to pods, good ventilation of pods for proper drying and storage of pods in dry and well-ventilated areas.

Transfer of technologies to farmers

Integrated management technologies for aflatoxin contamination have been transferred to Nigerian farmers through on-farm testing between June and October 2012. The purpose of the activities was to show farmers the effect of manure or gypsum application on aflatoxin contamination using variety JL 24. Treatments used were: 2.5 t ha⁻¹ of manure applied prior to planting, 400 kg ha⁻¹ gypsum applied 35 days after sowing, and an application-free control.

In collaboration with the Federation of Unions of Producers of Maradi (FUMA Gaskiya) and the NGO AGPR (Action pour la Promotion des Groupements Ruraux), six trials were established in Gaba Guidan village (Gaya, Dosso) and three in Elkolta village (Guidan Roumdji, Maradi). The tests were conducted by volunteer members of women farmers’ organizations in the two villages. Field days were held during crop harvesting at demonstration sites.
in each village with the goal of demonstrating best practices for harvesting and drying to a wide range of farmers. Other partners contributing to the field days organization included the agricultural extension service, the community radio Hausa Serkin (Maradi) and FRA'A Gaya (Dosso).

Radio broadcasts in local languages (Hausa and Zarma) have been instrumental in enhancing awareness of the technologies with farmers. Demonstrations of best practices for harvesting and drying (improved method) included a comparison with traditional practices so farmers could identify the advantages of improved methods.

More than 500 farmers from 11 districts of Dosso and Gaya attended the open day organized at Guidan Gaba, while over 600 farmers from 11 districts of Elkota and surrounding villages (Guidan Roumji, Maradi) benefited from the knowledge transfer. The trials helped answer a number of issues raised by farmers in relation to quality groundnut cultivation and consumption.

In Mali, more than 200 farmers from 20 villages in Sirakelé and N’Golonianasso in the Koutiala region participated in a training program on aflatoxin management, along with 30 extension agents from AMASSA AFRICA GREEN (a non government organization), Association Malienne d’Eveil au Développement Durable (AMED), and other NGOs. The training sessions addressed several issues on aflatoxin management in groundnut, such as good farming practices, use of aflatoxin-resistant varieties, appropriate soil fertility management methods, good harvesting practices, and post-harvest drying and storage techniques. During the on-farm field sessions, farmers were introduced to appropriate harvesting, drying and shelling techniques.

These activities were part of the CGIAR Research Program on Agriculture for Nutrition and Health, which seeks to bring together research-for development initiatives on agricultural practices, interventions, and policies for better adaptation, to maximize health and nutrition benefits, and to reduce health risks.
Scaling-up climate services to support farmer decision-making under a changing climate: mission possible

Reaching farmers with pertinent, downscaled and decision-relevant climate information and advisory services is required in order to improve their resilience.

A number of road blocks complicate the process of climate information production and delivery:

- Incomplete knowledge of the needs of farmers end-users; and their limited input into the process of climate service development;
- Insufficient infrastructure to deliver information (electricity, cell phone towers, etc.);
- Inappropriate timing, content, scale, or format of climate and weather information;
- Farmers’ lack of access—or inequitable access to ensuring that women, poor and socially marginalized groups are served—to communication technologies;
- Farmers’ lack of understanding for complex information, or lack of trust for what they do understand;
- Pertinence: tailoring content, scale, format and lead-time to farm decision-making;
- And, of course, the lack of appropriate data — lack of historical climate data, which precludes calculation of future climate projections; and the lack of complete datasets for agriculturally relevant variables, including precipitation, river flow and humidity; as well as coordinated research to deliver as one on farmer information needs.

It takes a concerted effort to ensure all the elements of effective climate and weather information and advisory services (delivery, pertinence, legitimacy and equity) are delivered to and utilized by farmer communities, and by individuals within them, that need such information the most.

One solution to overcome this challenge and reach farmers at scale is to build strong partnerships between the National Meteorological Services and National Agricultural Research and Extension Services.

Partnering to reach “the last mile” with climate services.
Climate information to manage farming risk

Using probabilistic seasonal forecasting to improve farmers’ decision making in Kaffrine, Senegal.

Although agriculture and pastoralism occupy 80% of the population in the Sahel, climate information is not yet widely integrated into farm management decision systems.

Seasonal climate forecasts could have considerable potential to improve agricultural management and livelihoods for smallholder farmers in the Sahel, which has significant year-to-year seasonal rainfall variability. Despite the many constraints related to capacity to respond, data scarcity, inadequate information services, policies or institutional processes in the region, there is considerable potential to overcome them.

A project using probabilistic seasonal forecasting to improve farmers’ decision was implemented in Kaffrine. Kaffrine is located in the peanut basin of Senegal where agriculture is the first source of income and employs 90% of the population.

The project objective is to foster dialogue between farmers and producers of climate information in order to provide tailored products that will increase farmers’ resilience to food insecurity.

From 33 farmers in six villages in 2011, the network reached 123 targeted farmers located in various locations spanning the whole region, further outreaching several thousands through: sms, local radio, meetings and television. This is a pluridisciplinary approach at two levels: national (mainly national institutions located in Dakar) and local (extension services in Kaffrine). The partners included the national weather service (ANACIM), volunteers from World Vision and the Red Cross, agricultural advisers (ANCAR), department of agriculture (DA), national agricultural research institute (ISRA), management of water resources (DGPRE), NGOs (ENDA-energy) and at local level, farmers’ groups (women producers), seed producers and extension services.

Methods and approach used

Building trust: The project sought to build the trust of farmers, while working with all relevant local organizations. It was very important that the project team did not appear as a stranger in the system, but as working through known entities. We worked with local technical services including agricultural advisers from the national agency for agricultural and rural advice (ANCAR), which has a presence nationwide at district level and a mandate to advise farmers in term of agricultural strategies, and volunteers from World Vision, a Christian NGO. Participants included individual farmers, and members of farmer organizations such as JAPPANDO. Women represented about 30% of those participating.

Connecting with farmers through indigenous knowledge: There was a clear need for a common ground, where farmers would readily accept a new scientific seasonal forecasting approach without feeling that their indigenous approaches to seasonal forecasting were being rejected. The strategy was to listen to them and understand the aspects of their traditional knowledge that might be climate related. The farmers were welcomed as guardians of knowledge passed from generation to generation, and invited as experts to share their indigenous climate knowledge.

Training: Another challenge was how to explain to farmers how rain could be forecast one to two months ahead and to help them to understand the probabilistic nature of forecasts with this lead-time in easy-to-understand terms. Many farmers knew about weather forecasts communicated through the weather bulletin on national TV. Seasonal forecasting was explained to the farmers by calling upon their intuition. It was explained that an “ocean has better memory of the past compared to a continent. That’s why, on a very hot day people go to the beach to benefit from ocean memory of the past weeks”.

Partnerships for a resilient agriculture
Assessment of the approach: An evaluation workshop was organized in Kaffrine to assess the use and usefulness of the seasonal forecast strategy. Fifteen trained farmers were compared to thirteen others farmers who hadn’t received information about seasonal forecasting. Trained farmers used a short cycle crop because the season was expected to be shorter than the previous year, but with sufficient rainfall. Those who had never received any climate information laid their plans based on knowledge of the previous year’s rain, leading them to choose a long-cycle variety, buying fertilizers and hiring wage laborers. Some trained farmers were not able to make full use of the seasonal forecast because they had already saved their seed stock from the previous year’s harvest.

Challenges: The main problems encountered were the high spatial variability of the rainfall, the late occurrence of the first rainfall making it difficult to judge when to start planting, a long dry spell, and early termination of the season. They wanted to know or get the starting date, more finely-tuned forecast information, a weather bulletin every two weeks, and more training to better understand the forecast. The evaluation revealed that farmers are now demanding climate products and rely heavily on them for their crop choices, planting activities and investment choices.
Partnerships to develop and disseminate pearl millet varieties

Partnerships within ICRISAT’s pearl millet breeding program for WCA evolved in several innovative ways during 2012. We share specific examples that highlight our current partnerships and how they are contributing to strengthening the national pearl millet seed production system in Niger.

Participatory varietal development/selection

ICRISAT has collaborated for several years with farmers’ unions at three Sahelian sites in Niger to create and improve new pearl millet varieties building on local landraces.

Materials from C2 and C3 cycles of selection with different individual farmers from each site were recombined manually at Sadoré during the 2010/11 post rainy season, and then bulked up in 2011 rainy season isolations at ICRISAT Sahelian Center (ISC) in Niger. The recombined bulks for these farmer-participatory-bred varieties from Tera, Falwel and Serkin Haoussa were each sown in four farmers’ fields in their respective villages of origin during the 2012 rainy season. The plots received moderate levels of mineral fertilizer and compost, and were thinned to a single plant per hill. As panicle emergence began, groups of farmers were shown how to use parchment paper selfing bags and paper clips to control pollination, and then selfed one panicle each on a thousand plants per plot over a two-week period. At crop maturity, the groups then selected about 200 selfed plants from each plot. One of the sets of materials at Serkin Haoussa was managed exclusively by women, while women were involved in the groups selfing and selecting plants in all of the other sets.

The harvested selfed panicles from selected plants were threshed individually at the ISC and the resulting sets of selfed progenies screened against downy mildew under greenhouse conditions using a particularly virulent pathogen isolate. The 2-replication downy mildew screens gave reasonably repeatable results (broad-sense heritabilities of 60-70%), with disease incidence values of individual selfed progenies from each farmer’s field ranging from zero to >80% (compared to means of 10 to 24% for resistant check ICMV-IS 90311 and 94 to 98% for susceptible check 7042(S)). Sets of 50 selfed progenies from each farmer’s field were selected on the basis of good germination and low downy mildew incidence (averaging 5 to 14%, compared to 24 to 44% for the 11 screened selfed progeny sets). The selected progeny sets were recombined manually during the 2012/13 off-season to produce nucleus seed for the three varieties (one each for Tera, Falwel and Serkin Haoussa) for entry to the formal variety testing system. This breeding scheme takes advantage of locally adapted germplasm (both local landraces and improved or exotic materials chosen based on on-farm performance), selection for adaptation to locally relevant soil and moisture conditions in the farmers’ own fields, selection for appropriate maturity, panicle and grain characteristics by the farmers themselves, as well as progeny-based selection for disease resistance and exploitation of irrigated off-season breeding nursery facilities at ISC for recombination of the selection portion of the population – producing pure seed stocks large enough for future experimentation and initiating village-level seed multiplication.
Roadside demonstrations of improved varieties

During the 2012 rainy season, roadside demonstrations of improved pearl millet varieties (released and in the pipeline) were conducted at a dozen sites in western south-central Niger. Most were linked to Certified Seed multiplication being undertaken nearby.

Farmers had the opportunity to compare the performance of four ICRISAT pearl millet varieties - including locally popular improved varieties SOSAT-C88 and ICMV-IS 89305, as well as ICRI-Tabi and Mil de Siaka, which are in the pipeline for possible release in Niger.

Farmers were particularly impressed by the excellent performance of the high-tillering, compact-panicled, medium-early-flowering variety ICRI-Tabi, which despite some mildew-infested plants showed good levels of resistance against both headminer and Striga, combined with excellent agronomic performance. It too is being prepared for Niger’s national list of recommended varieties.

Rainy season seed production

The ICRISAT Sahelian Center distributed over six tons of pearl millet Breeder Seed and Foundation Seed to seed producers in Niger in 2012. Although much of this was purchased by farmers under contract to the small number of local seed companies in this country, a substantial number of farmers associated with our farm union federation partners FUMA Gaskiya and Mooriben were also involved.

With support from the HOPE and McKnight Seeds projects, farmer union members from five villages in Niger successfully undertook seed production of improved pearl millet varieties during the 2012 rainy season. At the end of the season, initial reports indicated that 19 farmers from four villages had produced >60 tons of seed of four improved varieties. Similarly, two commercial seed producers near Maradi reported production of 10 tons of improved seed, with millet headminer infestation reducing production of SOSAT-C88. They propose to take up production of variety ICRI-Tabi next year based on its superior performance in roadside demonstrations.

Estimates of rainy season 2012 Certified Seed production in Niger indicate that ICRISAT-bred pearl millet varieties were multiplied on 1450 ha (15% of the total national pearl millet Certified Seed production area). Preliminary production estimates from farmers producing for small seed companies in western Niger indicate individual producers obtained 5,200 head bundles of ICMV-IS 89305 (70 t gross, and perhaps 60 t net); 1,350 bundles of ICMV-IS 92222 (15 t gross), 3,700 head bundles of ICMV-IS 99001 (40 tons gross); and smaller quantities from smaller plots of GB 8735, ICMV-IS 94206, and SOSAT-C88. From this, it appears clear that pearl millet Certified Seed production in Niger can grow to meet increasing demand, provided enough Breeder Seed and Foundation Seed can be made available.
ICRISAT itself got into the act during 2012 by producing 18 tons of Breeder Seed and nearly 10 tons of Foundation Seed of the increasingly popular variety ICMV-IS 89305 on a large isolated plot at the ICRISAT Sahelian Center. This exceptional multiplication was undertaken to reduce the bottleneck in Breeder Seed and Foundation Seed supply that limits Certified Seed production in Niger, as well as to bring a larger portion of the research station’s arable crop area back into use, and to provide information on field variability.

Falwel Seed Fair

Our partners Madé Bane – the farmers’ union in Falwel – hosted their first Seed Fair in 2012. This event on 29 April was both the culmination and celebration of two years’ experience with the mini-packets seed system developed with ICRISAT and the Institut National de Recherche Agronomique du Niger (INRAN). Several seed-producing farmers’ unions took part in pilots.

These examples demonstrate our partnerships – with the formal sector and with farmer unions, between research and development activities – that are improving the confidence of farmers, seed producers and the agricultural development community in Niger that better pearl millet production technologies are available and in the pipeline, and can be widely accessible to facilitate improved productivity.
Determining the best selection strategy to breed sorghum for phosphorus-poor soils

Sorghum in the Sudanian zone of West Africa (WA) is extensively cultivated in fields with low phosphorus (P) availability. The levels of plant-available P can be extremely low; for example a median of only 5.5 ppm (mg P kg-1 soil) was observed in a sample of 207 Malian farmers’ sorghum fields, whereas 10 ppm is considered as the threshold for sufficiency.

Although P-deficiency is known to reduce growth and delay maturity, sorghum is commonly cultivated in this zone with little or no fertilization due to farmers’ limited access to credit and fertilizers. In fact, one important role of sorghum for these farmers is to provide some production under low soil-fertility conditions in which other cereals such as maize are more likely to fail.

Nevertheless, sorghum breeders in West Africa typically conduct trials and nurseries under well-fertilized conditions, seeking to avoid uneven growth due to poor and variable soil-conditions that may reduce genetic gains from selection.

This study was conducted to determine to what extent selection under low-P conditions is feasible or necessary to breed varieties for farmers who regularly grow sorghum under low-P production conditions, and to what extent varietal differences for yielding ability are distinct between low- and high-P conditions.

Height differences on August 19 in a sorghum trial sown on July 8 with both low (foreground) and high levels (background plot) of plant-available P.
Grain yields of 70 sorghum varieties were assessed in a series of trials with and without P-fertilization over five years at two locations in Mali, West Africa. These varieties represented the range of diversity of varieties currently developed for cultivation in the Sudanian zone of Mali, including both farmer landrace varieties as well as a range of bred varieties with differing levels of local- versus introduced-genetic backgrounds. Modeling of within-field spatial variation was used to enhance precision of the genetic estimates.

The reliability of data from individual low-P trials was quite acceptable, with average repeatability estimates of 0.75, which was only marginally lower than for the high-P trials (0.81). The heritabilities, the portion of total variation in multi-environment analyses due strictly to varieties, was actually the same over both low- and high-P trials, with low-P trials having somewhat more error (noise) but actually larger differences among varieties when scaled for the relative yield levels of those trials.

Despite yield levels of the P-fertilized trials being double that of those that did not receive P-fertilization (averaging 1.8 vs. 0.9 t/ha), varieties were generally ranked quite similarly for grain yield between the two sets of trials. Yet, a few landrace varieties showed specific adaptation to low-P conditions (Figure 1). For example, a landrace from Cameroon (IS 15401) obtained from the ICRISAT Genebank, showed major yield superiority under low-P but not under high-P conditions.

A pre-test calculation of expected response to selection indicated that direct selection for yield under low-P conditions would be most effective for improving yield under poor soil fertility conditions. In contrast, indirect selection based on grain yields in high-P environments was predicted to be only 88% as efficient for improving yield under low-P conditions.

These results encourage more extensive sorghum yield testing under low-P conditions, especially when targeting farmers with low-input production conditions in West Africa. If, in contrast, selection was to be done under higher-P conditions only, there would be a risk of losing some of the best low-P adapted progenies or varieties. These results are useful in the improvement of our breeding strategy, increasing the extent of low-P yield testing in the overall selection program. The study also suggests that West African sorghums are likely to provide useful source material for identifying genes and traits that confer adaptation to low P-availability, a topic of current importance for smallholder farmers in sub-Saharan Africa, and of long-term interest for sustainable global production within the perspective of depleting worldwide P resources in the next 50–70 years.

Figure 1: Linear regression of grain yield of 10 best yielding sorghum genotypes in –P and +P conditions against the environmental mean Bray-1P soil value. Slope estimates are significant (t-prob. ≤0.05), except for genotype NAFALENP6, IS 15401 and B2-5.
Over the past decade, ICRISAT developed a range of new sorghum varieties as well as hybrids that correspond to farmers’ needs with Malian and other West African partners. The hybrids are more adapted to the vagaries of climate and pest outbreaks in West Africa, have grain yield superiority over traditional varieties, and grain quality for local food uses and with a range of stover qualities. While farmer participation in the process of variety development and evaluation was very effective in identifying varieties and traits that are of specific interest to producers in the target regions, the spread and diffusion from these small-scale efforts cannot lead to large-scale adoption without large-scale seed production and dissemination.

What was to be done in the absence of private seed companies? This was the question we faced 7–8 years ago.

The approach the team took was to find farmers interested in commercial seed production among those who participated in conducting and evaluating variety trials. They were trained in seed production issues, and decided to commercialize seed of the new varieties chosen by them, as members of an existing farmers’ group, or by forming a seed cooperative. As commercial high quality seed for staple crops of new varieties was an unfamiliar commodity to most farmers in Mali and other West-African countries, selling sorghum seed was not without problems.
Initially, sorghum seed quantities produced by the cooperatives were low, and in some years not all the seed produced could be sold as such. However, with advances in breeding varieties with new traits, such as dual-purpose grain/fodder types, and use of radio campaign/programming to inform farmers of new seed possibilities, the demand for high quality sorghum and pearl millet seed rapidly increased. In fact, demand has outpaced supply such that all seed produced has been sold in each of the past four years.

The recent development of photoperiod-sensitive sorghum hybrids based on locally adapted germplasm creates still further new opportunities for farmers to obtain major yield increases as well as providing a new cash crop: hybrid seed. Additional expertise is needed for successful hybrid seed production require, e.g. sowing both male-and female-parents in alternating strips, so farmers are being trained through both formal training courses for farmer seed cooperatives and exchange visits to current seed producers. Farmers then ‘learn by doing’, initially on small plots and then graduating to large-scale production. Farmers’ interest in producing hybrid seed is really taking off and bumping up membership of seed producers’ organizations, to the point that certain organizations had to place temporary limits on new membership.

Ingredients for this success include training, farmer-to-farmer exchanges, and an economic model that excites farmers. With hybrid seed being a ‘cash crop’, prefinancing of fertilizer is feasible. Rolling funds were established at first, but now seed producers’ organizations on their own to provide fertilizer to their members. With fertilizer, producers can obtain the same amount of grain from their male-parent strips as they normally would from their entire production area without fertilizer. The income from sale of the hybrid seed produced on the female parent is then a bonus on top of their normal grain production, and farmers can combine both food production and income generation in the same field.

The potential contribution of hybrid sorghum seed to energizing formal production is demonstrated by one small farmer seed producers’ cooperative (COPROSEM) that is achieving exponential increase of quality seed produced. This cooperative, founded by farmers who participated in testing research-bred varieties and wanted to produce the new seed, is setting an example for other farmer seed producer organizations in Mali and neighbouring Burkina Faso, which are keen to launch their own hybrid seed production.
Sweet sorghum could be one of the key crops to stave off the threats to food and energy security resulting from climate change.

Within a private-public partnership initiative piloted by Malibiocarburant (www.malibiocarburant.com) and ICRISAT, Malian farmers lead the way in integrating improved sweet sorghum into their traditional production systems.

This activity has been initiated to develop a sweet sorghum value-chain model focusing on integrated energy production by small-scale sorghum growers and livestock holders for local markets. The first phase will see sweet sorghum used to produce grain for human consumption as well as fodder from the sweet stems before the extracted sweet juice will be used for the production of bioethanol in a later phase.

Climate change, energy security and food security are the three most important global phenomena of our times leading to challenges related to food supply and food prices. In most West African countries the challenges of land degradation and desertification, compounded by the lack of access to energy and effects of climate change, are alarming. Bioenergy is the most discussed topic as it offers viable energy security. However, African countries are also concerned that the bioenergy revolution could marginalize the poor, raise food prices and degrade the environment by intensive resource use.

Sweet sorghums have been identified to have great potential as an energy crop (first generation ethanol production), without compromising food security as these sorghums are producing grain in addition to sugar rich stalks and are less demanding in water and fertility needs compared to other energy crops (sugar cane and maize). The leaves and bagasse (crushed cane) are rich sources of fodder for animals.
In 2012, 96 farmers in the Koulikoro region (Ouelessebougou) opted to grow 1 ha each of sweet sorghum to benefit from the improved grain yield and animal fodder generated by four different multi-purpose varieties provided by ICRISAT/IER. Unlike the local sweet sorghum varieties which are characterized by low grain production and quality; the new sweet sorghum types identified by ICRISAT and IER have sweet stems combined with high grain production (brix values over 15% and grain yield performance on-station of more than 2 t) and potential fodder production of up to 11 t/ha (dry stem weight without leaves).

Farmers’ acceptance of the new sweet sorghum variety types was the crucial starting point for this novel initiative. In 2011/2012 a series of on-farm trials and evaluations were conducted in collaboration with ICRISAT and farmer organizations in Koulikoro and Dioila.

Women and men farmers were very much impressed by the new varieties when they discovered their multiple uses and how they could increase the returns/hectare from their own fields. When cattle treated to sweet sorghum stalks refused to eat other fodder, the farmers called for increased promotion of the technology. Knowing the importance farmers give to the quality of grain for traditional food preparations, culinary tests with farmers were conducted in the Koulikoro region, and the same varieties went into culinary tests at the research station following a standard protocol developed at ICRISAT.

Results showed that women and men liked all white-grained sorghums for the different food preparations. For the crucial parameters of decortication efficiency (measured as percentage of flour weight compared to grain weight), especially for “caudatum” race sorghums, only one variety proved to be less efficient and at least two had the same efficiencies as elite guinea lines (>80%), confirming the positive contribution to food security of this variety type new to Mali.

Technicians from the ICRISAT and the Mali Biocarburant foundation supervised farmers in Ouelessebougou during the growing season and assisted with training and field visits as well as a credit scheme to enable access to fertilizer.

The first sweet sorghum harvest proved a success, with an average of 1.3 t/ha grain production, or almost double what the farmers would normally have harvested when using local varieties and traditional management. Such was the farmer enthusiasm for the sweet stems that not a single stalk was left in the field. Stalks were either sold by the women on the market as a snack, or kept for animal fodder. Due to the strong demand, but depending on availability of seed, it is aimed to involve about 250 farmers in 2013 into the initiative. Each farmer will grow 1 ha of sweet sorghum.

ICRISAT is in the process of registering four sweet sorghum varieties in the national catalogue.
Empowering women to access climate change-beating groundnut varieties

Its nutritional value and income-generating potential make groundnut an ideal crop to contend with the malnutrition and poverty that threaten the West Africa region in light of climate change.

Groundnut remains the major source of livelihood for small-scale farmers in Mali, Niger and Nigeria. Recent surveys in these countries show that groundnut is planted on about 36% of total cultivated area in Mali, 15% in Niger and 34% in Nigeria. The crop contributes to 64% of household cash revenue in Mali, 66% in Niger and 54% in Nigeria. It is generally seen as a woman’s crop in West Africa, with 85% of private/individual plots in Mali belonging to women and 35% in Niger. In Nigeria, there is little female participation in groundnut production activities, but the local groundnut processing activities are dominated by women.

Women are essential in the fight against the challenges of malnutrition and poverty but rural women are themselves disproportionately affected by poverty as well as unequal access to productive resources and social services such as land, health and education.

In the context of present and future climate change, scientists are already targeting specific plant traits to breed new crop varieties that will perform better under climate change. In West Africa, variable rainfall, drought, foliar diseases and aflatoxin contamination are important constraints to groundnut productivity and quality. Most of these are likely to be aggravated by climate change. Fortunately, a range of improved varieties are available and in the pipeline.

ICRISAT is working with a range of partners, including public institutions and NGOs, to empower women individually or in groups to access these climate-smart varieties. These are the highlights of activities in 2012:
Mali

Twenty two new varieties (9 short duration and drought tolerant, 5 resistant to foliar diseases and 8 tolerant to aflatoxin contamination) were tested in mother trials in 40 villages involving 1,450 farmers (85% women). Promising lines were selected by farmers for further evaluation in a paired comparison test during the following crop season. About 1750 farmers (90% women) received on-the-spot training in integrated aflatoxin management and Integrated Crop Management (ICM) practices.

The women’s association of Wacoro produced a total of nine tons of seed of the preferred variety Fleur 11 (Alason) and has been linked to a local private seed distribution company, Faso Kaba, for certification. Other women groups were trained in best practices for producing quality groundnut seed.

Niger

In Niger, Participatory Variety Selection (PVS) trials were conducted in five villages involving 63 farmers. In addition to evaluating new varieties, women groups in both Mali and Niger were trained in the production of high quality seed of released varieties. Women’s groups in Gaya in Niger’s Dosso department are producing 65% of the certified seed in Niger. Seed producers have been linked to grain producers to supply local processors with good quality produce, thus creating a market pool for quality seed production. The women seed and grain producers have been assisted with draft animals and ploughs, and processors in turn have been assisted with small-scale oil extraction machines to reduce drudgery associated with groundnut production and processing, respectively.
Cluster-based approach targeting women to enhance the groundnut value chain in the Dosso region in Niger

Women farmers play a major role in community-based groundnut seed systems in the Dosso Region of Niger thanks to intervention by ICRISAT and its partners.

During the last 10 years, ICRISAT and partners have successfully built up women community-based groundnut seed systems in the Dosso region through the Common Fund for Commodities (CFC) in funding the Groundnut Seed Project in West Africa, and of the Bill and Melinda Gates Foundation through the Tropical Legumes 2 project. Farmers now have access to good quality seed and are producing good quality grains. Interventions have been relatively successful in the production sub-sector but the processing and marketing sub-sectors remain the weak links in the groundnut value chain. SWOT analyses have been conducted to show that the major up-grading options include (1) ensuring access to a consistent supply of high quality grains to processors, (2) facilitating access to proper equipment to process groundnut into oil, cakes or pastes, (3) training processors in business and marketing skills, (4) linking processors to credit sources, and (5) linking processors to traders who can sell the products.

Therefore, a pilot economic experiment was set up as a proof of concept for enhancing the groundnut value chain. Four clusters were formed in the Dosso region, each with about 100 women processors. The cluster-based approach has the advantage of helping farmers/processors pool the demand for raw material and to sell the processed products collectively. The villages involved are Moussa Dey, Guidan Gaba, Sambera and Gaya, which were selected on the basis of the large volume of groundnut oil, cakes and pastes processed. Four other villages were selected as control sites with similar socio-economic characteristics as the project villages but where groundnut is processed by hand.
Resolving the poor access by processors to high quality grains

Processors source the raw material from the spot markets. Processors from Guidan Gaba purchase grain from the neighboring markets, especially the Malgorou market. Processors in Gaya source groundnut from markets at Tanda, Sia, Ouna, Malgorou and as far as Malanville in neighboring Benin. Grain supplied in the market is of variable quality and prices vary significantly. At harvest in 2011, the price of a bag of groundnut cost 10,000 FCFA and went up to 22,000 FCFA/bag shelled in March/April 2012. This price variation poses significant threats to processing activities.

In order to address this constraint, producers of grains and processors in the Gaya region met to ensure a consistent supply of 1,800 tons of seed to processors and thereby reduce price variability. Formal contracts were established in each cluster between the two parties. Contractual attributes include the type of variety, the mode of payment (cash or credit), the price formulated at 20% above the on-going market rate at time of purchase and the quality of the raw material (less than 2% physical impurities). These contractual arrangements are currently being monitored for compliance and difficulties in meeting the contracts. However, to facilitate such contractual arrangements, access to credit became important.

Improving access to credit for processors

Obtaining credit has been difficult and given mixed results to processing groups in Guidan Gaba and surrounding villages so a fresh approach is extending their borrowing potential.

They have previously gained credit experience with the financial institution ASSU DENDI. For example, the group GANI KORI JI YA in Guidan Gaba contracted a loan of US$2,600 at 12% interest for a 5 month loan (25% annual interest rate). Similarly, the processing group of Gaya Town contracted about US$2,000 per group, consisting of 10 women, under the same conditions.

In general, though, credit is not readily available and when accessible it is of relatively low volume and costly. The repayment periods do not match with producers’ cash flow and producers incur high transaction costs in fulfilling monthly payments due to the long distance traveled to the credit center. The Project has established contacts with the Agricultural Bank (BAGRI) and a rural project is ready to provide a guaranteed line of credit to BAGRI at the level of US$100,000. This will allow farmers to access working capital at cheaper prices and at the required volume to purchase raw materials and equipment.
Improving access to processing equipment

A need assessment on equipment showed that the lack of decorticators and processing machines were the major constraints. On an experimental basis, the TL2 Project supplied two mechanical decorticators and two small-scale oil processing machines in each of the five clusters. An ex-ante profitability analysis of equipment showed a high return to using decorticators as well as the processing machines. Decorticators helped processors save on average 2.7 minutes of time per kg of groundnut dehusked and reduced costs by 2.5 FCFA per kg. In addition, the use of processing and, especially, milling equipment reduces time by 0.75 minutes and costs by 6.25 FCFA per kg. For oil extraction, processors gained an average 5.5 minutes and 18.75 FCFA per kg of shelled groundnut processed.

The use of both decorticators and oil processing machines by processors contributes to reducing labor time by 22.2 minutes and costs by 27.5 FCFA/kg of groundnut shelled. Equipment is being monitored as to its replacement by the women processors.

Marketing of groundnut oil, cakes and paste

There are no assured markets for processors of groundnuts in the Dosso region for whom gaining access to markets for groundnut products remains a major challenge.

Processors sell four main types of processed products, subdivided to include groundnut oil, paste, cakes, Kuli Kuli, Digadigué and roasted nuts. All processors target their local market by selling to traders who supply the urban markets, of which the major examples are those of Gaya, Gaya, Gaya, and Gaya.
Dosso, Niamey, Baleyara and Malanville (Benin). Often, because of lack of coordination between processors or of collective action, processors sell the products as individuals and cannot bargain with traders. This contributes to a low volume of processing and subsequent sales of groundnut products, which in turn prevents capital accumulation.

This low level of activity gives traders cause to complain of poor quality of product, especially groundnut oil. In fact in some villages, processors often mix groundnut oil with palm oil. This practice considerably reduces the oil quality and creates a strong disincentive to purchasing groundnut oil.

To resolve the poor access to markets, the project liaised with two large traders in urban Niamey who each expressed interest in buying 5,000 liters of groundnut oil per week. This translates into a demand for grain (raw material) of about 1,800 tons of shelled groundnuts per year.

Management teams at cluster level

Sustainability of such interventions is assured by a management team in each cluster, including the President of the women’s association, the treasurer and the auditor. These were either set up or strengthened (as appropriate) and trained in small-scale business and management skills. In addition, in each cluster, a man and a woman were trained in using the decorticator and processing equipment and making small running repairs. Technical backup in using processing equipment was provided during 2011/12 by a partner CDMA, a processing equipment supplier.

Monitoring and evaluation

Very simple data forms were supplied to equipment operators to collect information on the use of the equipment, the costs and revenues generated. This is collected on a monthly basis by the project team.
Women millet processors groups modernize and commercialize their products in Northern Nigeria

Modernization and marketing is helping increase the demand for the traditional millet-based product *fura* across class barriers in urban Nigeria.

As a result of the efforts by women’s processor groups based in Jigawa State, better quality products are improving sales, profit and employment. One such group, the Fura women processors’ cooperative society of Gumel, was assisted by ICRISAT Kano and a locally based NGO, the Green Sahel Agricultural and Rural Development Initiative (GSARDI), through the HOPE project ‘Harnessing Opportunities for Productivity Enhancement (HOPE) of Sorghum and Millets in Sub-Saharan Africa and South Asia’.

Before ICRISAT’s intervention, and following a SWOT analysis and needs assessment, the major entry points to the value chain in need of upgrading included the poor access to high quality grain due to current sourcing from the open market, high processing costs due to inefficient traditional cooking stones that also create cleaning and health challenges because of the high release of carbon soot on the cooking materials, limited storage capacity for processed products and generally poor quality products due to improper packaging and product presentation.

They also had problems in accessing middle class customers, who like to buy their product but were concerned about the health implications. ICRISAT teamed up with GSARDI to support the women’s groups through training in hygiene and sanitation, the use of energy-saving stoves, and by linking them with sorghum and millet producers’ groups and Celsian Mills Ltd, of Gumel. They were helped in obtaining a deep freezer, modern cooking stove, utensils and electric generator.

This training and equipment quickly generated increased income for the group comprising 25 women processors led by Hajia Zainab Mai-fura. Prior to the ICRISAT intervention, Hajia Zainab’s group employed six daily workers, but now employs an average of 10 workers (six women and four men) per day. During festival periods, or when there are important meetings and events in and around Gumel, up to 20 workers can be required to cope with the additional demand for *fura* and other products.

From processing just 50 to 100 kg of millet per day and selling only *fura*, Hajia Zainab now processes 150 to 250 kg millet per day and has doubled sales income to US$4,000 a month. Diversification has introduced new products, which include *fura* ball, *fura* coarse powder, *fura* mixed with yogurt or milk, and milk or yogurt on their own. Sales of the fresh products have become possible thanks to the provision of a generator for refrigeration and modernization has improved cleanliness in other ways.

Hajia Zainab has renovated her own shop and bought other equipment such as milling machines. She notes that her profit margin has increased tremendously thanks to an energy-efficient stove that consumes less fuel and has improved product hygiene sufficiently to attract non-traditional customers.

Now the group is handling more cash, she believes the next steps for the group should include training in business development, as well as linkages to the National Agency for Food and Drug Administration and Control (NAFDAC) for certification. This will allow them to package their products for sale to other parts of the country.
CGIAR Research Program on Dryland Systems

Sustainability of the microdosing technology – crop residues and manuring

Africa’s Green Revolution will not happen on its own but technologies such as microdosing can be a key to unstopping bottlenecks to agricultural development.

Agricultural production in the arid areas of West and Central Africa is practiced in a fragile environment characterized by (1) low soil fertility (highly degraded soils), (2) harsh climatic conditions (highly variable rainfall in time and space, and high temperature) and unstable socio-economic conditions (weak economic power of rural households).

These are the major bottlenecks but evidence from across the centuries shows that external input makes agricultural development or green revolution possible. The Asian green revolution, which resulted in a tremendous increase in fertilizer use per ha (more than 80 kg/ha nowadays), is testament to this. However, the appropriate conditions must be created for such a significant increase in input use, particularly when the multiple constraints mentioned above put the activities of dryland farmers at a high risk which must be managed sustainably.

The development of microdosing technology by ICRISAT and partners is aimed at supporting dryland farmers with this management process. Results from the implementation of this technology have demonstrated yield increases of up to 120% (Tabo et al., 2007) with a corollary of nutrient export, which needs to be addressed.

Baidou et al. (1995) and Michel et al. (1995) reported insufficient crop residues on-farm after harvest to meet all the multiple purposes of residue use. On the acidic {4 – 5 (pH H2O)} sahelian soils with low carbon content (0.22%) used for millet production, making such a successful technology sustainable requires additional study.

Studies initiated by ICRISAT in 2003, 2008 and 2010 confronted this preoccupation. In both 2003 and 2008, three planting densities (15,000, 10,000 and 5000 hills per ha) were employed, two millet varieties (HKP and Sadoré local) and four soil fertility management options (Control, DAP (diammonium phosphate) at planting + 1 g of Urea at stem elongation (boot stage), NPK at 6 g per hill, and NPK at 3 g per hill were imposed.

The first 2003 experiment (experiment 1) was conducted until 2007 with removal of crop residue at harvest while the second (experiment 2) is still on-going in 2012 as millet stover from each plot was cut and spread on the plot until the following season. The third experiment (experiment 3) started in 2010 and involves three factors. In terms of soil fertility management, it employs a combination of four rates of organic fertilizer with four rates of mineral fertilizer.
Ten millet varieties are used in this study. In addition, stover harvested on each plot was not removed but left in place. Both organic and mineral inputs were hill-applied. All the fields used for the experiments had been in fallow for more than 10 years. By basing our report on total biomass production in line with the principal farmers’ preoccupation at household level, it is possible to show the trend observed in all three experiments.

As reported earlier, nutrient application resulted in all cases in tremendous yield increase following application of input compared to zero inputs. However, after three years (experiment 1), total biomass yield was reduced by 68% in the control plot and by 50% on average for the amended plots (Figure 2). The lowest drop in biomass yield was the 42% change recorded in plots receiving 6 g NPK per ha. No grain was harvested in their fourth and fifth year and stover was negligible and not accounted for. In experiment 2, biomass yield decreased by 50% in the control plots and by 37% on average in the amended plots (Figure 3) after three years of cropping. Although these two experiments were not conducted in the same conditions, comparing the two does show that the presence of the millet residue probably resulted in less of a yield drop. Nevertheless, total biomass production continued to decrease to reach 77% on average in all treatments in the fifth year.

In experiment 3, total biomass yield decreased by 38% on average in the control plot and 30% in the amended plots. This is lower than the reductions seen in experiments 1 and 2, and may be the result of adding manure. Looking at the effect of each fertilizer treatment on total biomass drop, we observe that it reached 55% in the absolute control, which is within the range of trends observed in experiment 2. However, as the fertilizer rate increases, the scale of the yield drop decreases (Table 1).

Table 1: Millet biomass yield decrease as affected by organic and mineral fertilizer microdosing after three years of cropping. Sadoré 2010–2012.
System approach for sustainable intensification

Combining and integrating technologies for increased farm level productivity in southern Mali

Three initiatives that will adopt a systems approach for sustainable intensification in Southern Mali started in 2012: (i) The Africa Research in Sustainable Intensification for the Next Generation (Africa RiSING), a project funded by the United States Agency for International Development (USAID) and operating in Mali in Bougouni and Koutiala Regions, (ii) The CGIAR Research program on Dryland Systems (Crp 1.1) and (iii) Pathways to agro ecological intensification in Southern Mali, a project funded by the McKnight Foundation and led by Wageningen University in the Netherlands, operating in Koutiala Region. These three projects are composed of an inter-disciplinary research team linking with stakeholders in the region (NGOs, Farmer Cooperatives, Extension services).

Why a systems approach?

Promising production-enhancing technologies have been identified by numerous past research and development projects to help farmers improve components of their farming system: stall feeding of livestock, improved varieties of early and dual-purpose legumes, fodder shrubs, improved organic resources management, fodder legumes, cereal-legume intercropping systems and many more. Unfortunately, these technologies remain largely on the shelf and are only sporadically used by farmers. Indeed, most previous research has tended to focus on intensification of the individual system components – crops, livestock, tree or human factors. The low adoption rate is partly due to research typically not following a systems approach. As a result, the way in which component technologies fit into the farm system were overlooked, and important constraints for farmers such as availability of labour and draft power were not taken into account.

Smallholder farms in southern Mali are complex systems combining different components: crops, livestock and trees interacting with each other (see Figure 5). The management and production of one component affects the management and production of another component. For example, growing an early and dual-purpose cowpea variety can improve fodder availability and allow for stable feeding of a part of the herd (dairy cows) in the dry season.

Figure 5: A representation of the key components of smallholder farming systems in sub-Saharan Africa. The farm is composed of different fields, herds, and a manure production unit. Arrows represent possible interactions between components. Fertilizers are inputs from outside the system. (Adapted from Giller et al., 2011, Agricultural Systems)
season. This will in turn lead to increased manure quantities and availability, which could be used to improve soil fertility of fields with low fertility. The Plant Production System research group at Wageningen University has developed a set of models and concepts that can help us to analyse these complex interactions, and systematically evaluate promising options to increase productivity at the farm level and through this, improve smallholders’ livelihoods and increase their resilience. The studies will tend to address those issues of system understanding, with permanent cross pollination between the three projects operating at different scales from the field and farm level to the village territory level in different locations and with different stakeholders.

System analysis and modeling to analyze scenarios trade-offs and risk.

System analysis and modeling provide an interesting discussion tool for: (i) scenario analysis, e.g. what would be the impact on household food security if a farmer combines on his farm integrated soil fertility management with stable feeding of goats or dairy cows during the dry season? (ii) trade-off analysis, e.g. what would happen if the farmer dedicates his labor more to livestock than on crops or if he uses his income to buy fertilizer instead of medicinal treatments for livestock? (ii) risk analysis, e.g. what would be the impact of mineral fertilization on cereal yield in the event of a dry year, in the event of a wet year, or even over a long time period?

2012 as a primer for those combined efforts for system analysis.

In 2012, the CGIAR Research Program on Resilient Dryland Systems conducted a biomass assessment to assess productivity of fields and pastures. Those field measurements, combined with satellite imagery, will allow for better determination of productivity of fields and pastures. A typology of farms (based on farm assets and evolution trend) was established within the McKnight “Pathways to agro-ecological intensification” project. This typology was submitted to farmers’ appraisal and will form a base for trials design, system analysis and modeling activities. Discussions were also initiated among farmers on pathways to move from a type of low-resource endowment to a type of higher resource endowment. Some initial on farm participatory trials on maize-cowpea intercropping were also carried-out. Farmers engaged in 2012 trials form a network of stakeholders involved in technology testing for sustainable intensification. They will be key partners in the future of this system approach for participatory design of intensification scenarios to improve livelihoods in southern Mali.
In continental West Africa, the rapid autumnal collapse of the monsoon system ensures a relatively stable end of rains across the years.

Recent and compelling quantitative evidence links photoperiod sensitivity to the geographical location of origin of pearl millet (*Pennisetum glaucum* [L.] R.Br.). Wherever the season’s duration is long enough to be variable, and wherever the season is short enough to remain uni-modal, photoperiod sensitivity is a key trait to ensure stable yields, plant adaptation, and adoptability of elite lines by smallholders. This characteristic applies verbatim to other regionally prominent cereals and legumes including sorghum (*Sorghum bicolor* [L.] Moench, esp. Guineense), rice (*Oryza glaberrima* Steud.), cowpea (*Vigna unguiculata* [L.] Walp.), and bambara nut (*Vigna subterraneean* [L.] Verdc.). By demonstrating the correlation between photoperiod sensitivity and seasonal variability features at the origin of accessions, two “Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung” (BMZ) funded research projects shed light on a powerful device in our adaptation arsenal for changing climates.

**First**, West Africa’s climate is more intricate than previously thought. Much diversity lies behind the monotonous relief of the world’s warmest rainfed agricultural domain and its misleadingly smooth north-south rainfall gradient. Comparing spatial patterns of total annual rainfall and average length of growing season is a simple, yet powerful appetizer towards full dissection of climate complexity in the region. Within the Guinean agro-ecological zone, Tamale (09°24’N, 00°51’W) receives the same amount of rainfall as Kenieba (13°6’N, 11°24’W) but has almost two months longer of a growing season. Within the Sudanian agro-ecological zone, Bamako (12°39’N, 8°0’W) has the same length of growing season as Ouagadougou (12°21’N, 1°32’W) but receives 250 mm more rainfall on an average year. Temporal differences in the seasonal moisture supply hold priceless clues for the understanding of plant adaptation. Making sense of regional climate complexity for plant science in turn requires access to spatially expansive time series of daily weather data, out of the public domain and hence rarely available. With Agrhymet and other partners, ICRISAT assembled the most comprehensive daily weather database for the region, with close to 40,000 station-years over 1,000 locations.

**Second**, West Africa’s climate is unique. In this largest landmass under the Tropics, global oceans combine influences with land surface conditions in complex ways to yield seasonal moisture regimes that are obviously variable, and more importantly, unpredictable. It was shown that in West Africa, inter-annual rainfall totals are less volatile – and yet less predictable – than in Southern Africa where precipitation is more closely tied to more predictable oceans. Another major peculiarity of West Africa’s climate lies in the way rainfall is distributed within a season: the contrasting association of a slow, spring-time monsoon establishment with a rapid, fall-time withdrawal results in more stable ends of season than onsets. Over Burkina Faso, it takes twice as much time for monsoon to establish itself (100 days) than it takes to retreat (50 days). Unfortunately, we showed with the University of Florida that prediction skill for the onset date of the rainy season systematically decays to non significant levels when downscaled to the local level where plants and farmers operate, meaning that there is no simple, reliable and actionable method to forecast the arrival of rains.

It should therefore not surprise that in West Africa, crops and farmers select to evade risk linked to uncertain onsets, rather than attempt to reduce that uncertainty strictu senso (impossible for plants and extremely challenging for humans). Stable end-of-season dates contrastingly provide a stimulus to synchronize flowering. Photoperiod sensitivity equips plants with a device to detect minute changes in day length which, in the regional context, is equivalent to a fine tuned ability to scent the imminent seasonal drop in the moisture supply. With farmer-mediated
towards relay or even dual cropping, higher-order descriptors of seasonal moisture distribution are required to predict yields.

Insufficient recognitions of i/ fine scale differences in seasonal regimes and resulting agro-climatic diversity, and ii/ the importance and role of photoperiod sensitivity in sorghum and millet-based systems were widespread in the wake of the great Sahelian droughts of the 1970-80s. They often led to the indiscriminate promotion of earlier-maturing lines even in foreign Sudanian and Guinean agro-ecologies where minimal changes in the seasonal rainfall patterns did not clearly warrant it. Such external introductions may locally induce agro-ecosystem damage, as is for example suspected today in the observed high prevalence of sorghum midge (Stenodiplosis sorghicola) in eastern Burkina Faso. Likewise, assuming that end-of-season dates remain stable under climate change, photoperiod sensitivity will continue to constrain meridional movement of elite cultivars in the region and offer a potent, but latitudinally specific mechanism for handling climatic uncertainty. Pearl millets of West Africa provide an eloquent illustration of this geographic stratification.

selection relatively undisturbed up to recent times, local genetic pools conserve a large reservoir of landraces featuring contrasted photoperiod sensitivities directly a function of latitude. With Institut d’Economie Rurale (IER) in Mali, University of Hohenheim, and CIRAD we showed that these sensitivities are actually correlated with the differential variability in start- and end-of-season dates at the locations of origin of 428 pearl millet varieties.

The local relevance of this adaptation trait is highest along a Sudano-Guinean longitudinal belt where farmers rank onset date of rains as the most important determinant of crop performance – implicitly acknowledging photoperiod sensitivity as the actual prime determinant, with onset date its visible surrogate. Many a scientist has erroneously interpreted farmer rankings as a motive to improve onset detection, rather than to enhance evasive preparedness given an incompressible uncertainty of onset. Away from that belt, photoperiod sensitivity remains present, but its expression is increasingly muted: further north in the Sahel where seasons are shorter, total annual rainfall gains importance; further south where seasons are longer and where agricultural systems tend towards relay or even dual cropping, higher-order descriptors of seasonal moisture distribution are required to predict yields.

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At the centers:

ICRISAT activities 2012

This year we welcomed farmers and several VIPs, from ministers and NGOs to delegates of international development organizations, to our research stations in Mali, Niger and Nigeria. 2012 was also special as we celebrated our 40th anniversary, the event gathering numbers of partners in each location, both to take stock of the achievements of the last four decades and look forward.

Training for farmers and technicians

The number of trainees at ICRISAT - West & Central Africa increased significantly in 2012. As in the past, applications emanated from different universities, NGOs, collaborative institutions and partner organizations. The 53 registered trainees – 14 women and 39 men – came from the following institutions: Universities of Niamey (Niger), IPR-IFRA (Katibougou, Mali) Bayero University, (Kano, Nigeria), University of Ghana (Ghana), Ouagadougou (Burkina Faso), Kassel (Germany), Ghent (Belgium) and Hohenheim (Germany), and IPDR (Niger), ENAM (Niger) and partners such as ISRA (Institut Senegalais de la Recherche Agricole).

Ten trainees are pursuing PhD programs and 20 are in MSc programs. Between ICRISAT-Niamey, ICRISAT-Mali and ICRISAT-Nigeria, a total of 4097 participants, comprising 2240 females and 1857 males, attended twenty-seven (57) training courses. That participants came from a multitude of national and international institutions and NGOs within many countries is an indication of ICRISAT’s increasing role in capacity building on agriculture and related areas in West and Central Africa.

Nigeria: Seed inspectors/certification officers trained

ICRISAT-Nigeria conducted a two-day training program for seed inspectors and certification officers at the National Agricultural Seeds Council (NASC) North West Regional Office Complex, Samaru, on 26–27 March. Organized under West African Seed Alliance Seed Project (WASA-SP) in collaboration with NASC, it included inspectors and certification officers from NASC, internal quality control officers from private seed companies, and seed officers of National Agricultural Research Institutes (NARIs) and Agricultural Development Programs (ADPs) of some selected States of the Federation.

Training on hybrid sorghum seed production in Mali

Hybrid seed production started this year in the Koutiala zone and is expanding in the Dioila (2nd year of production) and Mande (4th year) zones of Mali. To respond to the needs of new producers, as well as strengthen the capacity of existing producers, training sessions were conducted in each of the three zones by a team of ICRISAT and national program (IER) researchers together with a professional hybrid seed producer.

Malian farmer reviewing a lesson during the training session.
ICRISAT: 2012 events

ICRISAT@40: Anniversary celebration in West and Central Africa

In Chad, the 3rd Agricultural Science Week and 10th General Assembly of the West and Central African Council for Agricultural Research and Development (CORAF/WECARD) held in Ndjamen from 14–19 May saw the launch of celebrations to mark ICRISAT’s 40th anniversary and the reaffirmation of the Institute’s commitment to empowering smallholders in the region.

In Mali, renewed commitment and strengthened partnerships to improve the livelihoods of smallholder farmers living in the drylands of West and Central Africa (WCA) marked ICRISAT’s 40th anniversary day celebration held at the Samanko station on 5 October. Chief Guest at the opening ceremony in Mali were the Malian Minister of Agriculture.

In Niger, the Institute’s 40th anniversary was celebrated on 11–12 October. Among the chief guests were Mr Allahoury Diallo, High Commissioner for Nigeriens Nourish Nigeriens (3N).

Open Field Days and Visits

In Nigeria, a farmers’ field day (top right) was organized by ICRISAT Kano on 4 October at the research plots located within the Institute of Agricultural Research (IAR) Farm at Wase Minjibir, Kano. The field day, which was part of ICRISAT’s 40th anniversary celebration in Nigeria, showcased groundnut and sorghum breeding and management trials, some of which were demonstrated in selected Nigerian States to over 200 farmers, policy makers, scientists, extension agents and the general public.

In Mali, a Groundnut farmers’ field day was held at the ICRISAT research station at Samanko on September 27 to familiarize groundnut farmers with groundnut improvement activities, especially with recently developed breeding lines with resistance to foliar diseases and other attributes.

A sorghum farmers’ field day was also organized in Mali on November 6 to promote farmer-to-farmer learning.

ICRISAT Director General William Dar (center, right), along with ICRISAT-WCA Director Farid Waliyar visited several partners and donors in Ghana and Nigeria in June. On top of the agenda was strengthening ICRISAT’s research-for-development (R4D) activities.
USDA delegation visits ICRISAT Mali

A high-level US State Department (USDA) delegation visited ICRISAT Samanko station in Mali on 20 October. The group was composed of Eunice Reddick (Office Director, West African Affairs, USDA); Raffi Gregorian (Director, Office of Peace Operations, Sanctions and Counter Terrorism, USDA); Mary Norris (Director, Office of Accelerated Economic Growth, USAID in Mali); and Anton Ghost (Political Unit of the US Embassy in Bamako). On behalf of the delegation, Eunice Reddick acknowledged ICRISAT’s work in the region and its contribution to African agriculture and farmers, and pledged USAID’s continuous support to the Institute.

Belgian Embassy and Development Cooperation Bureau delegation visits ICRISAT-Mali

A Belgian delegation led by Ms Vandeputte Renata, Director, Division of the Belgian Cooperation Bureau in charge of supporting CGIAR finance, and staff from the Belgian embassies in Casablanca, Brussels and Dakar, visited ICRISAT’s Samanko station on 4 March. After a visit around the research facility, followed by discussions with the delegation they were shown ICRISAT’s off-season activities in seed production, random mating of plant populations, advanced breeding materials and experimental plots.

President of Niger visits a beneficiary farm of the WASA-SP project

On April 19, His Excellency Mahamadou Issoufou President of Niger visited a farm that has benefited from the support of the West African Seed Alliance Seed Project (WASA-SP). The farm, 25 km from the capital Niamey, is a success case built by Mr Hima Abdoulrazack with support from ICRISAT and the WASA-SP project, including technical support and provision of millet seed such as the variety SOSAT-C88.
## Who we are

### Scientific staff list

#### Bamako, Mali

<table>
<thead>
<tr>
<th>Name</th>
<th>Title and Responsibilities</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farid Waliyar</td>
<td>Director, West and Central Africa</td>
<td>France</td>
</tr>
<tr>
<td>BR Ntare</td>
<td>Assistant regional director/Principal scientist (breeding) – grain legumes</td>
<td>Uganda</td>
</tr>
<tr>
<td>Eva W Rattunde</td>
<td>Principal scientist (sorghum breeding and genetic resources) – dryland cereals</td>
<td>Germany</td>
</tr>
<tr>
<td>HFW Rattunde</td>
<td>Principal scientist (sorghum breeding and genetic resources) – dryland cereals</td>
<td>Uganda</td>
</tr>
<tr>
<td>Pierre CS Traoré</td>
<td>Remote sensing scientist and head of geographic information systems – resilient dryland systems</td>
<td>France</td>
</tr>
<tr>
<td>Tom Van Mourik</td>
<td>Special project scientist – dryland cereals</td>
<td>Netherlands</td>
</tr>
<tr>
<td>Robert Zougmoré</td>
<td>Principal Scientist/Program leader for West Africa Region – CCAFS</td>
<td>Burkina Faso</td>
</tr>
<tr>
<td>Aram Tall</td>
<td>Principal Scientist/Climatic Risk Management – CCAFS</td>
<td>Senegal</td>
</tr>
<tr>
<td>Kirsten Vom Brocke</td>
<td>Principal scientist/CIRAD</td>
<td>Germany</td>
</tr>
<tr>
<td>George E Okwach</td>
<td>Manager, HOPE project for sorghum and millet – dryland cereals</td>
<td>Kenya</td>
</tr>
<tr>
<td>Gatiene Falcornier</td>
<td>Associate professional officer (Crop Livestock Systems Modeling) – resilient dryland systems</td>
<td>France</td>
</tr>
<tr>
<td>Amadou Bila Belemgoabga</td>
<td>Regional administrator</td>
<td>Burkina Faso</td>
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<tr>
<td>Agathe Diama</td>
<td>Regional information and communication officer</td>
<td>Mali</td>
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#### Niamey, Niger

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<thead>
<tr>
<th>Name</th>
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<tbody>
<tr>
<td>Mahamadou Gandah</td>
<td>Country representative</td>
<td>Niger</td>
</tr>
<tr>
<td>Jupiter Ndeunga</td>
<td>Principal scientist/Economist – Policies, Markets and institutions</td>
<td>Cameroon</td>
</tr>
<tr>
<td>Fatondji Doubedji</td>
<td>Regional scientist / Agronomist / Soil and Water Conservation – resilient dryland systems</td>
<td>Benin</td>
</tr>
<tr>
<td>Hamidou Falalou</td>
<td>Regional Scientist / Physiologist</td>
<td>Niger</td>
</tr>
<tr>
<td>Tom Hash</td>
<td>Principal scientist/Pearl Millet Improvement program – dryland cereals</td>
<td>USA</td>
</tr>
<tr>
<td>Rodolphe Morales</td>
<td>Principal scientist/Crop diversification – resilient dryland systems</td>
<td>USA</td>
</tr>
<tr>
<td>Mensah Edouard Romeo</td>
<td>Associate professional officer (Economics) – Policies, Markets and institutions</td>
<td>Benin</td>
</tr>
<tr>
<td>Hassane Amadou</td>
<td>Regional finance manager</td>
<td>Niger</td>
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<tr>
<td>Gaston Sangaré</td>
<td>Regional farm manager</td>
<td>Mali</td>
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#### Kano, Nigeria

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<tr>
<th>Name</th>
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<tbody>
<tr>
<td>Hakeem Ajinde Ajeigbe</td>
<td>Principal scientist/country representative – resilient dryland systems</td>
<td>Nigeria</td>
</tr>
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