ICRISAT West and Central Africa

Working together with governments
to achieve national goals

Highlights 2017

2018

Citation: ICRISAT West and Central Africa. 2017. Highlights 2017: Working in Partnership with Governments to Achieve National Goals. Bamako, Mali: International Crops Research Institute for the Semi-Arid Tropics. 52 pp.

Front cover photo: A young West African agripreneur in a groundnut demonstration field in Mali.

Credit: A Diama, ICRISAT

About ICRISAT

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, nonpolitical organization that conducts agricultural research for development in Asia and sub-Saharan Africa with a wide array of partners from 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, Telangana, India, with two regional hubs and four country offices in sub-Saharan Africa. ICRISAT is a member of the CGIAR System Organization.

ICRISAT-BAMAKO
(Regional Hub -West
and Central Africa)
BP 320, Bamako, Mali
Phone: + 223 20 70 92 20
Fax: + 223 20 70 92 01
Email: icrisat@icrisatml.org

ICRISAT-NIGER
BP 12404, Niamey,
Niger (via Paris)
Phone: + 227 20 72 25 29
Fax: + 227 20 73 43 29
Email: icrisatcs@cgiar.org

ICRISAT-KANO
PMB 3491, Sabo Bakin
Zuwo Road, Tarauni
Kano, Nigeria
Phone: + 234 70 34 88 98 36
Email: icrisat-kano@cgiar.org

Contents

Message from the Regional and Research Program Director, West and Central Africa

This annual report is an overview of the major achievements in improving the livelihoods of farmers who are end users of the results of our research. The report highlights how our scientific interventions have increased domestic food supply and created jobs in Mali. It takes you through our major findings that have reduced malnutrition and land degradation in Niger. In Ghana and Burkina Faso, the interventions are helping to improve smallholder farming. The last section throws light on how ICRISAT together with its partners has succeeded in increasing community resilience to climate change with the use of climate information services and decision support tools in Senegal.

Farmers tell their stories best. Their perspective motivates us to serve them better; to help them tackle the vagaries of nature and the consequences of hunger, poverty, malnutrition and environmental degradation. The report fleshes out farmer stories from projects such as Harnessing Opportunities for Productivity Enhancement (HOPE II), Tropical Legumes (TL III), the Africa RISING Large-scale Diffusion of Technologies for Sorghum and Millet Systems (ARDT SMS), and the Increasing Groundnut Productivity of Smallholder Farmers in Ghana, Mali and Nigeria and many more project interventions in West and Central Africa.

A major successful initiative in 2017 was the launch of a Smart Food campaign in the region. Millet, sorghum and groundnut were promoted as crops that are good for the consumer, the planet and the farmer.

The report concludes with an overview of the driving force behind this research – the workforce in the region, and its support to building the capacity of stakeholders and partners in agricultural research for development in West and Central Africa.

Thank you for your support and I wish you a pleasant reading.

Dr Ramadjita Tabo

HIGHLIGHTS

Mali

Accelerating agricultural growth and family farming

Promising farmer-preferred and high-yielding sorghum hybrids

122 new hybrids tested with **30 farmers from 9 villages** in 3 agro-ecological zones during rainy season 2017

15 hybrids yielded 1.5-2.1 tons/ha of grain in on-farm trials across all environments

15 hybrids yielded 27-75% and 52-111% higher than the best released hybrid Fadda and local check Tieble, respectively

15 hybrids recorded better preference for combined plant architecture, grain aspect and grain yield potential (58-78%) compared to Fadda (49%).

Improving productivity of millet and sorghum on smallholder farms

Interventions of the Africa RISING's Large-scale diffusion of technologies for sorghum and millet systems (ARDT-SMS) project:

Improved technologies (high-yielding varieties, best agronomic practices and integrated *Striga* and soil fertility management) covered over 47,914 ha

60% yield increase from improved pearl millet and sorghum varieties compared to local checks

323 tons seed produced by seed multipliers under project supervision

48 tons certified seed distributed through Farmer Field Schools and demonstration plots in Sikasso region

95% female farmers | **98%** male farmers

are using improved seed delivery channels (mini-packs and agro-dealers) in Sikasso and Mopti regions

Net benefit from integrated *Striga* and soil fertility management + microdosing in sorghum: FCFA 135,425 (USD 246.22)/ha

Net benefit from profitable fertilizer-seed mixture (1:1) application in pearl millet: FCFA 117,485 (USD 202.32)/ha

Strengthening groundnut regional varietal trials networks

10 best-bet, high-yielding groundnut varieties tolerant/resistant to drought, foliar diseases (rosette, leaf spots) and aflatoxin under final stages of testing for evaluation and release in 2018/2019.

Increasing groundnut productivity of smallholder farmers

Seed produced:

7.86 tons	32.89 tons	272.53 tons
Breeder seed	Foundation seed	Certified seed

19 seed fairs link community-based seed producers to markets in Mopti, Sikasso, Kayes and Koulikoro regions

9,457 farmers access improved varieties in Mopti, Sikasso, Kayes and Koulikoro

7,788 Female

1,669 Male

3,633 ha under improved varieties in Mopti, Sikasso, Kayes and Koulikoro

↑ 42.25% gross margin for households using improved varieties

Awareness and adoption demonstrations conducted on integrated crop management practices (121) and aflatoxin management (116)

11,065 value chain actors sensitized to aflatoxin impact on human nutrition and health through media

2,576 Male

8,489 Female

8,479 farmers participate in field days | 6,678 Female | 1,801 Male

10,387 printed material produced on seed production and aflatoxin management

8,272 flyers | 2,100 brochures | 15 posters

12 television shows and radio programs were broadcast

25 shelling machines were acquired for distribution

Countrywide 10-meter cropland, crop type and crop condition map products produced[1]

Building on the legacy of the BMGF-funded STARS project (Spurring a Transformation for Agriculture through Remote Sensing; http://www.stars-project.org/en), Mali was registered as one of the three worldwide Sen2-Agri country pilots alongside Ukraine and South Africa. The focus ares of the pilots was: 1. Improving agricultural statistics; 2. Enhancing yield forecasts; and 3. Scaling agricultural insurance in close partnership with the national agricultural agency.

Building resilience among rural farmers with integrated climate smart approaches

Under a collaborative project with BRACED, conducted a series of field demonstration on Climate Smart Agriculture (CSA) practices

13,595 **smallholder farmers** (22% women) benefited from training and advisory services

5,000 farmers introduced to the use of seasonal and daily forecasts in their agricultural activities

Produced and disseminated a manual on using climate information for extension and NGO workers.

[1] https://ccafs.cgiar.org/blog/satellite-imagery-technology-better-agricultural-practices-mali#.WpRQV2ZFI24
http://www.copernicus.eu/projects/nadira Background publications: Schut et al. 2017 (in press, Field Crops Research); Lambert et al. 2017: http://ieeexplore.ieee.org/abstract/document/8035204/?reload=true

Niger

Reducing malnutrition and land degradation

Scaling up Bio-reclamation of Degraded Lands (BDL) to provide economic and nutritional benefits to households

The ICRISAT-Catholic Relief Services (CRS) Bio-reclamation of Degraded Lands (BDL) system converts degraded, crusted soils into productive lands by combining indigenous or improved water harvesting technologies, applying animal and plant residues, and planting high value nutritious fruit trees and annual indigenous nutritious vegetables.

Technology disseminated in 5 years

10,770 farmers in 170 villages

141 ha of degraded land were rehabilitated

Women earn profits ranging from

USD **500-800** from **200** m^2

rehabilitated area; spinoffs in the form of food diversification.

62% of farmers acknowledge ecosystem services of trees and role of Farmer-Managed Natural Regeneration (FMNR) to rehabilitate degraded lands.

Nigeria | Increasing domestic food supply and creating jobs

Agricultural Transformation Agenda Support Program (ATSP)-1 sorghum outreach assists farmers with best practices and capacity building[2]

>10,000 farmers
and small-scale processors (**including 4,662 youth and women**) trained in agribusiness activities, seed production, safe agro-chemicals' application and post-harvest activities

About 5,353 farmer group members
trained in Good Agronomic Practices (GAP) in sorghum

Farmers who adopted improved production technologies saw an increase in sorghum grain yields ranging from 38-64% (1.13- 1.7 t/ha) compared to 0.6 -0.8 t/ha among non-adopting/ participating farmers.

[2]Ajeigbe, H.A, F. M. Akinseye, I. I. Angarawai, S. A. Ummah, A. H. Inuwa, A. Adinoyi and T. Abdulazeez, (2017): Enhancing farmers' access to technology and market for increased Sorghum productivity in the selected staple crop processing zones". Proceedings of 51st Annual Conference of Agricultural Society of Nigeria (ASN); 23-27 Oct 2017. Agricultural Research Council of Nigeria (ARCN) Building, Abuja, Nigeria. Pp 1095-1099.

Increasing groundnut productivity of smallholder farmers

Seed produced:

9.8 tons	45.5 tons	372.6 tons
Breeder seed	Foundation seed	Certified seed

28 agro-input fairs link community-based seed producers to markets

Improved varieties accessed in Kano, Katsina, Kebbi, Jigawa, and Sokoto by

11,243 farmers	1,617 Female	9,626 Male

4,968 ha under improved varieties

54.32% increase in gross margin for households using improved varieties

438 demonstration plots established with at least one improved and local variety for comparison

4,017 value chain actors participate in field days

2,674	1,343
Male	Female

179 value chain actors (37 female; 142 male) trained in groundnut-driven Innovation Platforms

6,500,000 households
reached through regular broadcasts over 24 community radio stations in 5 project states

25 groundnut
motorized shelling machines distributed to farmer groups

Strengthening groundnut regional varietal trials networks

7 best high-yielding groundnut varieties tolerant/resistant to drought, foliar diseases (rosette, leaf spots) and aflatoxin are under final stages of testing for evaluation and release in 2018/2019.

Photo: V Meadu (CCAFS)

Senegal

Reducing livelihood vulnerabilities to climate change

Building the resilience and food security of Senegalese producers through proper use of climate information services (CIS)[3]-CINSERE Project

Produced and communicated 16 Climate Information Services (11 for farmers; 5 for fishermen) to over 100,000 people through SMS, voice messaging and radio broadcasts

2,900 lead farmers and fishermen train and sensitize 80,000 others in CIS use

78% of CIS farmer recipients satisfied with decisions taken based on information, in terms of resilience and yield improvement

89% CIS fishermen recipients totally satisfied with the decisions taken based on information about heavy winds and sea swell

Increase in crop yields compared to previous years due to:

CIS + improved crop varieties **49%**

Agro-met advisories **16%**

Fertilizers **40%**

[3]Issa Ouedraogo, Ndeye Seynabou Diouf, Mathieu Ouédraogo, Ousmane Ndiaye and Robert B. Zougmoré, 2018. Closing the Gap between Climate Information Producers and Users: Assessment of Needs and Uptake in Senegal. Climate 2018, 6, 13; doi:10.3390/cli6010013

Ghana

Improving smallholder farming

Increasing groundnut productivity of smallholder farmers

Seed produced:

9.8 tons Breeder seed | **52** tons Foundation seed | **146** tons Certified seed

21 agro-inputs fairs link community-based seed producers to markets

3,355 farmers reached

2,005	1,350
Male	Female

685 ha under improved varieties

67.73% increase in gross margin for households using improved varieties

152 participatory demonstrations combining improved varieties and good agronomic practices

6,552 **value chain actors** (3,685 female; 2,867 male) participate in 196 field days

10,557 **other actors** (6,323 female; 4,234 male) trained in improved varieties, seed production and integrated crop management

2,000 flyers and manuals on groundnut production and IPM distributed to value chain actors in the project area

80,000 households reached through 47 radio programs on groundnut production and aflatoxin management in three administrative regions of Northern Ghana.

Strengthening groundnut regional varietal trials networks

6 best-bet groundnut varieties [high yielding, tolerant/resistant to drought, foliar diseases (rosette, leaf spots) and aflatoxin] are under final stages of testing for evaluation and release in 2018/2019.

Photo: A Diama, ICRISAT

Photo: A Diama, ICRISAT

Burkina Faso

Improving smallholder farming

Actual and potential adoption rates of improved sorghum varieties[4]

15.7% adoption of improved sorghum varieties in 2014 from a survey covering 50 villages and 500 farmers

Strengthening groundnut regional varietal trials networks

4 best-bet groundnut varieties [high yielding, tolerant/resistant to drought, foliar diseases (rosette, leaf spots)] and aflatoxin are under final stages of testing for evaluation and release in 2018/2019.

[4] Submitted for publication to Journal of African Economies (JAE) on 14 December 2017.

INSIGHTS

Mr Lassina Sangare, a producer of sorghum variety Pablo, Tekere, Mali.

Photo: B Nebie, ICRISAT

Farmers prefer promising high-yielding sorghum hybrids for their cropping systems

Photo: A Diama, ICRISAT

Photo: K Isaacs, ICRISAT

A family of farmers in their sorghum field in Sikasso region of Mali.

Photo: A Diama, ICRISAT

Farmers in Southern Mali appreciate the perfomance of improved varieties during a farmer field day.

Photo: A Diama, ICRISAT

Farmers in Southern Mali during a farmer field day.

Photo: A Diama, ICRISAT

Mr Karamoko Sako, representative of the European Cooperative for Development (EUCORD) in a project intervention site in Mali.

Sorghum is one of the main cereal crops in West Africa. It plays a major role in the region's food and nutrition security. To boost sorghum productivity, hybrid development was initiated, and the first released material showed 30% grain yield advantage over local variety *Tieble* under different farming and input conditions (Rattunde et al, 2013). Based on this encouraging result, the development of hybrid female parents was initiated to broaden their genetic base. These hybrid female parents were then used to develop 122 new hybrids that were tested during rainy season 2017 with 30 farmers from 9 villages belonging to three different agro-ecological zones in Mali. Data on grain yield and farmers' preferences, disaggregated by sex were recorded using tablets. Farmer preference for each variety was then calculated based on the number of white, yellow and red cards they placed in the enveloppe associated with each plot.

$$\text{Preference (\%)} = \frac{[(NWC \times 1) + (NYC \times 0.5) + (NRC \times 0)]}{[NWC + NYC + NRC]} \times 100$$

Where, NWC, number of white cards ; NYC, number of yellow cards; NRC number of red cards.

Fifteen of these new hybrids yielded 150-200 g/m^2 of grain across all the environments, with 27-75% gain over the best released hybrid *Fadda* in the trials and 52-111% over the local check *Tieble*. All of them recorded better preference (58-78%) compared to *Fadda* (49%) (Figure 1).

Seed of selected hybrids are being produced in the off-season for the second year trials to confirm these findings. The most preferred hybrids will be proposed for release in the regional seed catalogue.

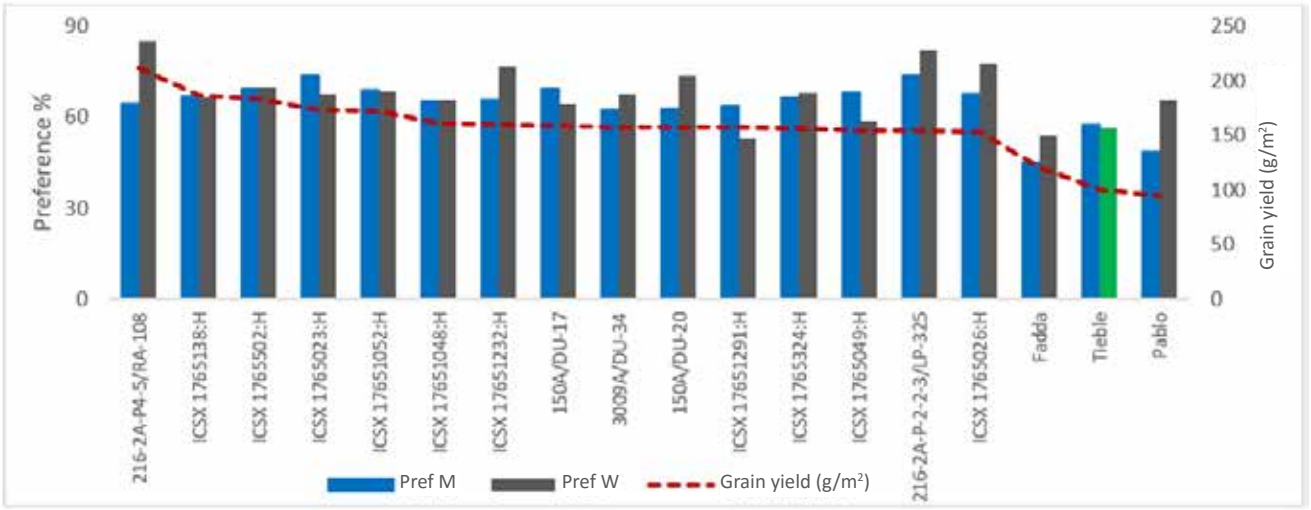


Figure 1: Grain yield and farmers' preferences for the 15 best sorghum hybrids compared to hybrids Fadda and Pablo and local check Tieble in 30 farmers' fields in Mali. Pref M=Preferred by men; Pref W = preferred by women

Strengthening groundnut regional varietal trial networks in WCA

Photo: A Diama, ICRISAT

A groundnut producer in Sikasso region of Mali during harvest.

Project scientist Dr Ayoni Ogunbayo in a groundnut plot.

A groundnut variety promoted by ICRISAT.

The groundnut breeding program at ICRISAT-WCA works with the national agricultural research systems (NARS) in the region to strengthen the multi-environment testing of breeding lines in order to identify improved varieties that are high yielding, tolerant/resistant to drought, foliar diseases (rosette, leaf spots) and aflatoxin for target environments. The sahel, sudan and guinea savannahs are the main target agroecologies.

During the 2017 crop season, two sets of regional varietal trials comprising 48 varieties were conducted in Burkina Faso, Ghana, Mali, Niger, Nigeria and Senegal. The partners were Institut de l'Environnement et de Recherches Agricoles (INERA) in Burkina Faso, Savanna Agricultural Research Institute (SARI) in Ghana, Institut d'Economie Rurale (IER) in Mali, Institute for Agricultural Research (IAR) in Nigeria, and Syngenta Foundation in Senegal. The locations per country varied from one to six. Promising lines identified from these networks of regional varietal trials will be evaluated as per the varietal release protocols of the respective countries, for release in 2019/20.

Besides, the program has also provided advanced breeding lines to NARS to organize preliminary and national multi-location variety trials in the last few years. This has resulted in the identification of 27 best-bet varieties (10 in Mali, 4 in Burkina Faso, 6 in Ghana, 7 in Nigeria) for potential release in 2018/19 (Table 1). In 2017, 132 breeding lines were provided to NARS programs (in Nigeria, Mali, Gambia, Democratic Republic of Congo, Ethiopia, Ghana, Niger and Senegal) for evaluation in preliminary variety trials and subsequent multi-location variety trials for identification of best-bet varieties for potential release in 2020/21.

Photos: Dieudonné Diama, ICRISAT

A beneficiary of the project with her produce.

Table 1. Best-bet groundnut varieties under final stages of testing by variety release committees, for potential release in 2018/2019.

Mali	Burkina Faso	Ghana	Nigeria
ICGV 00350	ICGV 86015	ICGV-IS 08837	ICGV-IS 07999
ICGV 03181	ICGV 91317	ICGV 13071	ICGV 94379
ICGV-IS 131085	ICGV 91328	ICGV 13075	ICGV 01276
ICGV-IS 131054	ICGV 93305	ICGV 91279	ICGV IS 09926
ICGV-IS 131079		ICGV 13015	ICGV-SM 08540
ICGV-IS 13871		ICGV 13110	ICGV-SM 07539
ICGV-IS 13830			ICGV 86024
ICGV-IS 13825			
ICGV-SM 99537			
ICGV 93437			

Delivering the first countrywide 10-meter cropland, crop type and crop condition map products for the developing world

Photo: A Diama, ICRISAT

Farmers in the field with their harvest in Mali.

Funded by the European Space Agency (ESA), led by Université Catholique de Louvain (Belgium) and implemented in Mali by ICRISAT, the Institut d'Économie Rurale (IER) and the Cellule de Planification et de Statistiques (CPS), both under the Ministry of Agriculture, Mali, Sentinel2-Agriculture (Sen2-Agri) aims to provide the international user community with validated earth observation (EO) algorithms and best practices to monitor agriculture. Sen2-Agri focuses on user-driven development of agricultural EO products, benchmarking and validating of required algorithms, and on the demonstration of resulting EO products and services to users of the global agricultural community. It builds on the unique capabilities of the Sentinel-2 mission, a transformative multispectral imager providing worldwide and free-of-charge, 10 m resolution on a 5-day repeat cycle (http://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Sentinel-2). Sen2-Agri is a major contributor to the research and development (R&D) and national capacity building components of the GEOGLAM initiative (http://www.geoglam.org/index.php/en) launched by the G20 Agriculture Ministers.

The four products of Sen2-Agri include monthly cloud-free surface reflectance composites and dynamic cropland masks, main cultivated crop type maps at the middle and end of the cropping season, and vegetation status indicators (vegetation index, leaf area index) delivered for each cloud-free observation. These products can provide up to 100 data points every 5 days in the absence of cloud cover on any smallholder hectare.

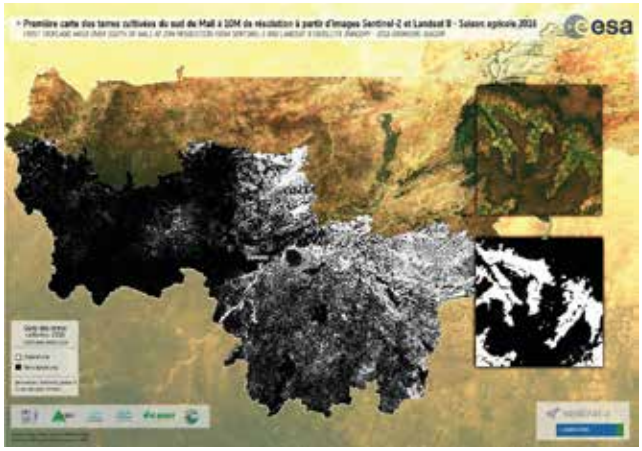
Building on the experience, partnerships and legacy of the BMGF-funded STARS project (Spurring a Transformation for Agriculture through Remote Sensing (2014-2016), ICRISAT and partners successfully registered Mali as one of the three worldwide Sen2-Agri country pilots together with Ukraine and South Africa. Covering 500,000 km^2 and representing a raw volume of ~4Tb of imagery per season, each country pilot aims to demonstrate system scalability and the robustness of methods, calling for the involvement of a national organization with a mandate for crop statistics or agricultural monitoring. The focus areas identified include:

Improving agricultural statistics. Mali's Cellule de Planification et de Statistiques (CPS/SDR) is responsible for the annual implementation of the permanent 'Enquête Agricole de Conjoncture' (EAC), and the periodic implementation of the 'Recensement Général de l'Agriculture et de l'Élevage' (RGAE) following a list sampling frame. In a developing economy with highly dynamic land use change, Sen2-Agri may unlock a number of improvements such as the use of area sampling frames.

Enhancing yield forecasts. Earth Observation plays a central role in the statistical estimation of crop area and yields. However, in smallholder agriculture these estimates are constrained by spatial resolution. Sentinel-2 increased the percentage of farm plots amenable to EO monitoring from 20% to 70% and showed a quantum leap in granularity and temporality of observations, allowing EO to transition from a research effort to an operational production process.

Scaling agricultural insurance. The Sentinel missions provide an opportunity to monitor crop condition in near-real time, and have potential to monitor scale smallholder agronomic practices and damage to crops to support the development of smallholder agricultural indemnity insurance and traditional weather and area yield index insurance. Sen2-Agri will help design and test new portfolios of socially differentiated insurance products to open business opportunities in smallholder markets.

Sen2-Agri contributed to the successful funding by the European Commission of the NADiRA H2020 innovation action on 'Nurturing Africa's Digital Revolution for Agriculture'. It is mapped to the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) under its Capacitating African Smallholders with Climate Advisories & Insurance Development project.



Using climate information services to build resilience and food security in Senegal

Listening to the radio in Sikilo village, where climate forecasts and farming advisories are available to more than 7 million rural people via community radio stations.

Photo: V Meadu, CCAFS

That information holds the key to development was illustrated in Senegal in 2017, when 16 Climate Information Services (CIS) relevant to farmer communities (11) and fishermen communities (5) were produced and communicated to more than 100,000 people through SMS, voice messaging and radio broadcasts. Part of the climate information services for increased resilience in Senegal (CINSERE) project, the activity aimed to facilitate and increase access to and use of climate information to improve the resilience and productivity of farming, pastoralist and fishing communities, through the proper provision, communication, and use of CIS.

To help users understand and effectively use CIS, 2,900 lead farmers and fishermen were trained, who in turn sensitized more than 80,000 additional users. By the end of the year, surveys were conducted to evaluate how the use of CIS had affected the farming and fishing sectors.

The evaluations revealed that in the farming sector, about 96% of the people who had received the training used it effectively, of which 78% were very satisfied with the decisions they have taken, in terms of it affecting resilience and yield improvement. In addition, the results showed that the use of CIS combined with improved crop varieties, fertilizers and agro-met advisories had substantially increased crop yields as compared to the control plots. For instance, rainfed rice yielded 2.04 t/ha, maize 2.68 t/ha and millet 1.48 t/ha, registering 49%, 40% and 16% yield increases respectively compared to previous years. In the fishing sector, 94% of the fishermen who received the CIS used it effectively, of which 89% were totally satisfied with the decision they had taken following the receipt of information warning them of imminent heavy winds and sea swell. On receiving these warnings, about 45% of the respondents decided to postpone venturing to sea; 15% decided to go to sea using life jackets; less than 1% took the risk to go to sea without safety precautions and the rest carried on other activities while awaiting a safer fishing period.

While recognizing that the decisions taken had negatively influenced their fish yield, the warnings and consequent decisions saved them from taking risks at sea. The use of CIS contributed to building the resilience of the beneficiaries, helped them face adverse climate events, and in ensuring food security.

The CINSERE project (2016–2019) is funded by USAID and implemented by ICRISAT/CCAFS in collaboration with the Malian national meteorological office (ANACIM).

Mrs Mariama Keita of Sikilo village at a climate services test site where she is helping scientists understand the impacts of climate advisories.

Photo: V Meadu, CCAFS

A training on participatory Integrated Climate Services for Agriculture (PICSA) at Meouane in Senegal.

A training on Climate Information Services (CIS) at Ziguinchor in Senegal.

The Integrated Climate Smart approach to building resilience among rural Malian farmers

Information at their fingertips: Farmers in Mali get first hand climate information on their mobile phones.

Photo: ICRISAT

Under a collaborative project with the Building Resilience and Adaptation to Climate Extreme and Disasters (BRACED) programme, a series of Climate Smart Agriculture (CSA) practices were demonstrated in the regions of Ségou, Mopti and Koulikoro to strengthen smallholder farmers' resilience to climate change. Zai and half-moon techniques and contour bunding were used to rejuvenate degraded lands and restore soil fertility. Smallholder farmers were trained in producing high quality organic fertilizer (compost), applying manure and chemical fertilizer using microdosing techniques. Field demonstrations were supported by a simple analysis to demonstrate the economic benefits of each technology as well as yield increase. A total of 13,595 smallholder farmers (22% women) were the direct beneficiaries of the technical training, support and agro-advisory service provided to improve farm production and living conditions.

Dissemination of weather information

Subsequent to the CSA trainings, a working group of 20 to 30 farmers was formed in 180 villages in the Ségou, Mopti and Koulikoro regions to empower communities to use climate information for decision making related to livelihoods, aimed at reducing risks. In total, 5000 farmers were introduced to the use of seasonal and daily forecasts in their agricultural activities.

This was done through the The *Sènèkèla/Sandji* Platform which was easily accessible to farmers throughout the country, providing advice on rural development, climate information, agricultural practices and management of crop diseases. *Sénèkela* is a service provider of real-time information on agricultural prices, advice on farming techniques, as well as the collection and provision of weather data. It operates seven days a week and is manned by specialist agronomists. *Sandji* is a decision-making tool that was developed to help small farmers plan their agricultural activities. At 7 am every morning, farmers receive an SMS in French or Bambara providing a 48-hour forecast of the predicted volume and intensity of rainfall, as well as the likelihood of rain in each time slot. They also receive monthly and seasonal forecasts. These highly accurate forecasts and knowledge of the price of agricultural products enable farmers to reduce risk and costs, increase yields and optimize their use of expensive resources. This means that they can make well-informed decisions throughout the agricultural cycle.

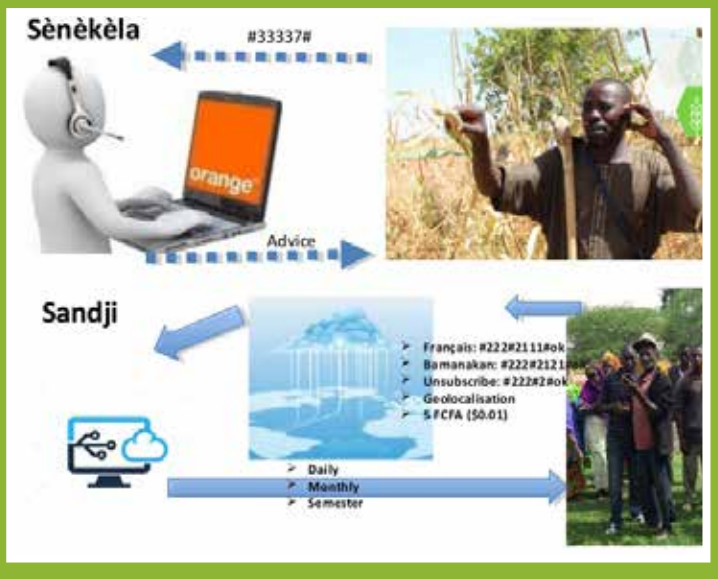
Mobile phones proved useful to disseminate weather and climate forecasts among farmers and enable decision making on the best dates to plough, sow, apply fertilizer, and even do the laundry in households.

To increase the sustainability of and access to the Sènèkèla/Sandji platform, public-private partnerships should be encouraged, together with a reduction in call/SMS costs or the adoption of a toll-free number to favor marginalized areas and populations.

Supporting extension workers in building resilience

Based on the analyses of stakeholder (farmers and extension workers) perceptions, ICRISAT produced a manual on the use of climate information for extension workers and NGOs in Mali, to support farmers in their daily activities. The manual essentially helps to:

- Better understand concepts related to climate change
- Provide clarity on climate data collection and generation of climate information services
- Know and advise actors on the correct use of seasonal, weekly and daily rainfall forecasts, thereby aiding them to make a choice depending on whether there will be deficit, normal or surplus rainfall.



Scaling up Bio-Reclamation of Degraded Lands (BDL) for economic and nutritional benefits to households in Niger

A bountiful harvest in a BDL field in Niger.

Photo: ICRISAT

About 73% of the African drylands are degraded and 51% are severely degraded (Dregne and Chou, 1992). In Niger, about 80,000-120,000 ha of land are annually degraded. Land degradation poses a severe threat to food production, food security, and natural resource conservation, particularly for the poor and vulnerable populations of the drylands.

The Bio-reclamation of Degraded Lands (BDL) is a climate smart and gender sensitive technology that helps regenerate the landscape by protecting the soil surface, increasing rainfall capture and producing biomass, thereby improving soil fertility. The system, developed by ICRISAT, strives to convert degraded crusted soils into productive lands by combining indigenous or improved water harvesting technologies (micro-catchments, planting pits, half-moon and trenches). It involves the application of animal and plant residues and planting high value nutritious fruit trees [moringa (*Moringa oleifera*), Pomme du Sahel (*Ziziphus mauritiana)]* and annual indigenous vegetables [such as okra, roselle (*Hibiscus sabdariffa*) and *Senna obtusifolia*] that are resilient to drought.

Using participative approaches with farmers and partners, ICRISAT implemented many activities to improve soil fertility and restore degraded lands, leading to two main achievements in 2017: (i) assessing farmers' perception on land degradation and (ii) scaling up BDL to provide economic and nutritional benefits to households.

Assessing local knowledge of land degradation

Using surveys and focus group discussions in four regions in Niger (Maradi, Zinder, Dosso and Tahoua) on a sample of 2,100 farmers in 57 villages, farmers' knowledge about land degradation, indigenous practices for improving soil fertility or restoring degraded lands and the role of trees in cropping systems were analyzed. Farmers identified four root causes of land degradation: population pressure, climate change (shortage of rainfall), soil preparation and the demand for wood. Farmers cited

A focus group discussion on land degradation.

Harvesting the fruits of her labor.

overexploitation of land, soil compaction, insufficient manure, silting caused by wind and water erosion, land clearing, tree cutting, and runoff as the main causes of land degradation and reduced arable land, slow plant grow and loss of biodiversity all consequently leading to desertification, hunger, food insecurity, poverty and conflicts on land resources (between farmers and pastoralists) and migration.

Farmers suggest solutions

About 62% of the farmers suggested the use of farmyard manure and rainwater harvesting technologies to combat land degradation. The importance of trees in cropping systems was well perceived by them. Also, 92% of the farmers acknowledged the important role of trees as windbreaks to protect sapplings, and their contribution to soil fertility, moisture conservation, reduction in runoff, increased crop yields, and providing fodder (*Acacia albida*) for livestock, supplying wood and providing shade. About 70% of the farmers suggested the adoption of Farmer Managed Natural Regeneration (FMNR) as a solution to degraded lands and sought training support. Only 23% of the farmers suggested tree planting as a solution to land degradation.

In partnership with Catholic Relief Services (CRS), the BDL technology has been disseminated to 10,770 farmers in 170 villages over the last five years. As a result, 141 ha of degraded land was rehabilitated.

The activity continued in the 2017 rainy season as the program decided to protect five sites in each of the two departments of intervention (Mayahi and Kantche) to ensure that the moringa and Pomme du Sahel trees are not eaten by grazing animals. In the 2017 rainy season, the activities were conducted on 86 sites in 73 villages. Knowing that leafy vegetables harvested during the season are mainly used for household consumption, an evaluation was done of the potential gain to a woman in terms of earnings if a 200 m^2 area is allocated to her. Results indicated that a woman can earn a profit ranging from US$ 500 (department of Mayahi) to US$ 800 (department of Kantche); the difference in earnings may be due to the individual's effort in caring for her plot (Figure 1). The scaling up process was extended to other projects led by ICRISAT.

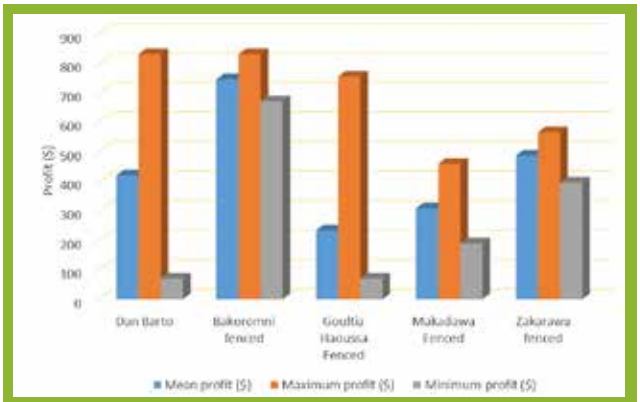


Figure 1. Profit earned from a 200 m^2 BDL plot in the department of Kantche, Niger, rainy season, 2017.

Assisting farmers with best practices and capacity building in Nigeria[1]

Training on sorghum processing, value chain addition and nutrition. Mrs Hafsat S. Ibrahim, Gender Officer (ICRISAT), explains how to add value to sorghum product composite.

Photo: ICRISAT

Youth farmers being trained in pop sorghum preparation during a nutrition field school.

Nigeria is the leading producer of sorghum in Africa and second in the world. The crop has the potential to be the driver of economic development in Nigeria. Moreover, improving productivity will play a critical role in feeding the growing Nigerian population that is expected to double in the next two decades. Access to and use of improved technologies play a key role in this.

The sorghum outreach component of the Nigerian Government's Agricultural Transformation Agenda Support Programme (ATASP-1) led by ICRISAT Nigeria since 2016 has been implemented in 4 Staple Crop Processing Zones (SCPZ) of Adani-Omor (Enugu and Anambra States), Bida-Badeggi (Niger State), Kano-Jigawa (Kano and Jigawa States) and Sokoto-Kebbi (Sokoto and Kebbi States) covering a total of 26 local government areas.

Since the project's inception in northern Nigeria, 439 technology demonstration plots targetting the use of improved varieties, integrated soil fertility management, seed dressing techniques and conservation agriculture were deployed and conducted in 120 communities.

Over 10,000 farmers and small scale processors (including 4662 youth and women) have been trained in various agribusiness, seed production, safe agro-chemical application and post-harvest activities. Other farmer groups comprising of 5353 members were trained in good agronomic practices (GAPs) in sorghum production.

In 2017, mean sorghum yields of farmers who had adopted all or some of the production technologies ranged from 1.13 t/ha to 1.7 t/ha, compared to

[1]Ajeigbe H A, Akinseye F M, Angarawai I I, Ummah S A, Inuwa A H, Adinoyi A, and Abdulazeez T (2017). Enhancing farmers' access to technology and market for increased sorghum productivity in the selected staple crop processing zones.

a mean of 0.6 t/ha to 0.8 t/ha among the non-adopting/participating farmers. This represented a yield increase ranging from 38- 64% (Table 1).

In the participatory technology demonstrations, seed dressing with Apron Star gave a mean 22% yield advantage over non-dressing; integrated soil fertility management showed a mean 46% yield advantage over the control; and conservation agriculture (mainly minimum tillage) had a mean 17% yield advantage over conventional tillage, while improved varieties had a mean 43% yield advantage over the control (Table 2). Mean grain increase across demonstrations ranged from 26% in Adani-Omor to 44% in Sokoto-Kebbi. The highest mean increase in grain yield was obtained from integrated soil fertility management (46%) followed by improved varieties (43%).

Table 1. Sorghum grain yields (t/ha) across 4 Staple Crop Processing Zones (SCPZ), 2017.

Staple Crop Processing Zones				
Yields	**Adani-Omor**	**Bida-Badeggi**	**Kano-Jigawa**	**Sokoto-Kebbi**
Potential yields (highest obtained)	3.75	3.4	2.17	2.36
Yields from participating farmers	1.7	1.13	1.5	1.7
Yields from other farmers (baseline)	na*	0.7	0.8	0.6
Yield increase (%)	na	38	47	64

* na = not available.

Table 2. Mean sorghum grain yields (t/ha) from farmer participatory technology demonstrations in Nigeria, 2017.

Staple Crop Processing Zones									
Technology	**Adani-Omor**		**Bida-Badeggi**		**Kano-Jigawa**		**Sokoto-Kebbi**		**Increase (%)**
	Control	Improved	Control	Improved	Control	Improved	Control	Improved	
Improved varieties	2.77	3.75	1.38	3.4	0.98	1.55	0.83	1.80	43
Seed dressing	na*	na	2.02	2.71	1.08	1.22	1.33	1.74	22
Integrated soil fertility management	na	na	1.97	3.18	0.58	1.34	0.62	1.39	46
Conservation agriculture	na	na	na	na	1.06	1.27			17
Mean increase (%)	26		42		31		44		

* na = not available.

SUCCESS STORIES

FARMERS HAVE THEIR SAY!

More power to women farmers through Village Savings and Loans Associations (VSLA) in Northern Ghana

(L) A Village Savings and Loans Association in northern Ghana and (R) a member's passbook.

Over the years, access to credit and loans required for sustainable agricultural production and productivity has been a major constraint to smallholder farmers in Africa. Majority of women farmers in Africa have limited or no access to land, labor, inputs and credit, due to socio-cultural and institutional factors. Interest rates charged on credit accessed from financial institutions often tend to be high for rural farmers, and require collateral. Access to land is often restricted to usufruct rights; women cannot provide collateral for credit because they may not have legal ownership of the assets, thus restricting access.

A number of programs aimed at enabling farmers to access credit by providing inputs while farmers repay with grains have yielded very little results. However, the issue of gender-based productivity gap has received increased attention in the last decade, facilitating research to identify and highlight the presence and underlying causes of the yield gaps. In order to bridge this gap, a study was conducted by a team of researchers from The Council for Scientific and Industrial Research of the Savannah Agricultural Research Institute (CSIR-SARI) working under the Tropical Legume III (TL III) project in Northern Ghana.

The research aimed to identify and describe the nature of resource allocation to male and female groundnut farmers; estimate productivity differences among them and lastly, to estimate factors that determine these differences. The study revealed that female farmers showed significantly lower productivity levels than their male counterparts due to, among other keys factors, minimal or lack of access to credit for agricultural production.

Transforming social and gender norms entails thoughtful identification and designing of interventions to improve access to key resources, services and support systems, a greater understanding of the impacts of cultural and normative practices among local communities, and challenging the manner in which they perpetuate inequality among men, women and all social groups.

Formation of VSLA

In Northern Ghana, The Tropical Legumes III partnered with NGO Social Enterprise Development (SEND)-Ghana to pilot a Village Savings and Loans Association (VSLA) in 5 districts (3 in the Northern regions and 1 each in the Upper West region and Upper East region). Each VSLA has 150 members across the pilot communities (Wantugu community in the Tolon district, Salankpang community in Mion district and Gbimsi community in West Mamprusi district).

The VSLA was used as a platform to help groups raise funds to support activities. The concept was the result of strategies developed at a gender workshop organized by the project. "The VSLA is a self-help initiative in which group members come together to raise funds through weekly or monthly contributions within a given period of time," explains Mr Desmond S Adogoba, Gender and Social Scientist, SARI/TL III.

"The objective is to give members the chance to save money that will be used for groundnut seed production in their respective communities, as well as support other households in on-farm activities which would have required borrowing money from external sources. The initiative equips members to be financially independent and strengthens the groundnut seed production system at the community

A cross section of the Wantugu Mansungsim Village Savings and Loans Association members.

(L) The VSLA kit composed of a calculator, a membership card, a metal box to keep the savings and two plastic boxes to collect money during meetings and (R) Mr Desmond S. Adogoba presents a VSLA kit to a community volunteer.

level. We are not only empowering women; we are engaging them in the seed system as well," adds Mr Adogoba. Each member is given a VSLA kit composed of a calculator, a membership card, a metal box to keep the savings and two plastic boxes to collect money.

Mrs Patience Ayamba, program coordinator for the SEND-Ghana Livelihood and Food Security program, based in the Salaga office, feels that collaborating with the TL III project has helped them expand their gender training activities and VSLA into Northern Ghana. She expects the partnership will result in incorporating the Gender Family Model Concept in which husband, wife and children are included in the communities. As she says, "VSLA is just a part of the Gender Family Model where both men and women understand their roles in the family. We have seen women actively participating in decision making at the family level and even at the community level and more women taking up leadership roles. In this model, we have seen men who are willing to support their wives in the household, paying more attention to children's health needs and women having their views heard by their husbands. We have seen this happen in the SEND-Ghana fostering project and expect the same results from these communities".

Mrs Dachia Midana and Hajia Poanaba Sumani, leaders in the Gbimsi Tilanngum VSLA say they will use the savings to expand their farmland: "We want to use the VSLA savings to cultivate 60 acres of groundnut in the 2018 cropping season".

Apart from this, the VSLA provides relief to members in terms of school fees of their children. According to Mr Sardi Linus Handua, Secretary of the Gbimsi Tilanngum VSLA, the average annual school fees for primary class students is 1000 Ghana Cedis (about US$ 200). "I joined the VSLA because I can save money, get credit for income generating activities that will enable me to pay the school fees of my four children who are all in high school. In fact, I can now pre-finance the school fees," says a confident Mrs Midana.

Project: Tropical Legumes III

Funding: Bill & Melinda Gates Foundation (BMGF)

VSLA community volunteers with (third from left) Mr Sardi Linus Handua, Secretary of the Gbimsi Tilanngum VSLA.

The power of 3: Women farmers front runners in creating community seed systems in Burkina Faso

Photos: A Diama, ICRISAT

(L) Mrs Zombra Maimouna (with bicycle) and members of the Pagou women farmers group, Burkina Faso and (below) groundnut seed producer Mrs Bambara Alizeta.

"Why is this project investing only in women," asks an incredulous Biyen Gaston, whose wife is a community seed producer in To, Burkina Faso. "If only I could get this improved variety, I could compete with my wife!" Biyen's wife is one of the 180 women involved in community groundnut seed production in Burkina Faso through the Tropical Legumes III project. Her production plot outyielded the local variety in 2016.

In Pagou, 200 kilometers from Ouagadougou, 50-year-old Bambara Alizeta has seen her life transform dramatically over the last two years. It all began in 2015 as a Multi-Stakeholder Platform (MSP) of the Centre East with three women in Pagou undergoing training on improved agronomic practices and improved groundnut varietal testing on 0.25 hectares. Two released varieties (SH 470P and QH 243C) were chosen for seed production. Bambara Alizeta (50) was among the three pioneers who were selected in 2016 to produce the first ever improved groundnut seed in Pagou. And when these women shared the seeds with 10 other women the following year, a community-based system was born!

Three members that a community seed producer shared her seed with in 2016, who in turn will share their produce with three others.

All community seed producers (about 90% female) in each MSP were trained in improved seed production and good agronomic practices. "Earlier, I used to grow an unproductive local variety whose seeds were too small and difficult to decorticate and which barely yielded much. I would sow any way I liked, Now I do the sowing in rows. I follow many other improved agronomic practices since I am trained for seed production. I even apply fertilizer to my groundnut field. Access to improved seed has allowed me to double my harvest to 2 bags (200 kg) from 0.25 ha, compared to 100 kg earlier," says Mrs Bambara Alizeta who is now growing early-maturing variety SH470P.

Pagou village now has 23 women seed producers chosen from different farmer's organizations. According to Dr. Amos Miningou, Groundnut Breeder at the Institut de l'Environnement et de Recherches Agricoles du Burkina Faso (INERA), nearly 180 women have been introduced to groundnut community seed production and 540 are expected by the end of the TL III project in 2018. "The project provided the initial foundation seed to the first 3 pilot women farmers. Each member was responsible for producing enough seeds for her own use and for sharing with two new members; that's how we aim to reach more members," he explains.

"The project has introduced not just women but our entire community to the production of quality declared seeds. Many others are eager to start groundnut production again," explains Bambara Alizeta. Without the support of the project and its multi-stakeholder plaform, I would not have accomplished all this," says Alizeta who has been a groundnut producer for the past 20 years.

Zombra Maimouna is another pilot producer. "When I and two other women started in 2016, it was for the first time that this type of seed was produced in our community. In my first year, I produced 63 kg of seed and the following year 90 kg. This has been an important breakthrough for me," she says.

The community seed system is also being used by women like Madam Cécile Belem who grows crops such as cowpea. A mother of six, Cécile Belem is a member of the Zondoma multi-stakeholder platform for cowpea. Inspired by the success of a varietal testing plot in 2016, she produced 1250 kg of improved cowpea varieties *Tiligré* and *Komcallé* over 1.5 ha. Like many producers in the region, her preference is for Tiligré for its better yield and better taste compared to local varieties and many other improved cowpea varieties. She justifies her preference thus: "In the case of a bad rainfall, Tiligré seeds do better. They do not blacken like other varieties of cowpea." Cécile sold nearly 200 kg of her produce and plans to use the money not to expand her farm but to help in intensification of production on the same plot."

Groundnut and cowpea are important crops in Africa as they allow growers not only to feed themselves and their animals but also serve as an important source of income, especially for women. Efforts to introduce improved varieties and increase their adoption were made under the Tropical Legumes project, with the intent of helping smallholder farmers improve yields, and ensure better incomes by growing varieties that are resistant to early and late leaf spot, aflatoxin contamination, and are also drought tolerant.

Project: Tropical Legumes III
Funding: Bill & Melinda Gates Foundation (BMGF)

Potential of new improved sorghum varieties boosts farmers' confidence in Nigeria

Photo: M. Magassa, ICRISAT

M Abdullahi Shehu (standing, second from right) with farmers keen on growing improved sorghum variety CF35.5.

"Friends have come asking for seeds of CF35.5 and KL1, two improved sorghum varieties to grow in their own fields. I didn't have to explain to them what the varieties were about. They animatedly described the sorghum grains as "big and pretty", as those in my field," says Abdullahi Shehu, pointing to CF35.5 plants.

Farmer Abdullahi Shehu from Zakirai in Kano state, Nigeria received from the HOPE project 500 g mini packs of two new improved sorghum varieties CF35.5 and KL1 seeds in June 2017. He planted these alongside his local variety. Three months into the cropping season, Abdullahi was surprised. CF35.5, a short variety (<1 meter in height) matured early and produced large panicles with bold grains even without fertilizer application. Another trait was its tolerance to the deadly parasitic weed *Striga*, a serious threat to sorghum in the area.

"I am very happy with the results. KL1 performed well too. It is almost at maturity with well-filled grains," he says. Impressed with the performance of the two varieties, Abdullahi wants to replace all his local varieties with these improved ones. For the next cropping season, he plans to stick to CF35.5 and KL1 in all his fields. He is willing to experiment further. "This is the first time I have tried new varieties from researchers. I intend to continue the trend," he adds.

Though Abdullahi Shehu is a champion and has encouraged **s**everal sorghum growers in the same village to take a step towards change, his case is not isolated. Across Nigeria and Burkina Faso, farmers who tried the seed mini packs have developed a strong interest towards new sorghum and pearl millet varieties because they yield higher and mature earlier than the local varieties.

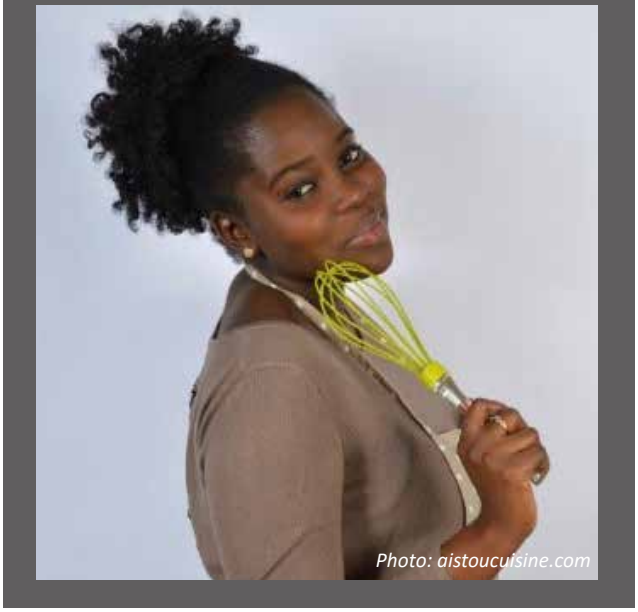
In the north central region of Burkina Faso, farmer Boukari Ouedraogo has had a similar experience with hybrid sorghum. "I tried growing a small quantity of hybrid sorghum Sariaso 22 that a fellow farmer offered me. The results were impressive. Next year, I will plant this variety on my 3 ha field," he concludes.

Project: Harnessing Opportunities for Productivity Enhancement (HOPE II) for Sorghum and Millets in sub-Saharan Africa

Funding: Bill & Melinda Gates Foundation

Partners: Institut de l'Environnement et de Recherches Agricoles (INERA), Burkina Faso; Institut d'Economie Rurale (IER), Mali; Institute for Agricultural Research (IAR) of Ahmadu Bello University (ABU) and Usmanu Danfodiyo University of Sokoto (UDUS), Nigeria; Ethiopian Institute of Agricultural Research (EIAR), Ethiopia; Department of Research and Development (DRD), Tanzania; National Semi-Arid Resources Research Institute (NaSARRI) of the National Agricultural Research Organization (NARO), Uganda; and ICRISAT.

Culinary blogging and social media promote better nutrition and dietary diversity



Culinary blogger Aissatou M'baye.

Often referred to as traditional and sometimes old-fashioned crops, cereals such as millets and sorghum have long suffered from unpopularity in the food system. Yet these grains are endowed with immense potential waiting to be revealed. Above all, they constitute a solution to the major problems facing the planet: rural poverty, malnutrition, climate change and environmental degradation.

In 2017, ICRISAT-WCA partnered with Senegalese culinary blogger Aissatou M'Baye based in Paris to create awareness on millets and sorghum, Smart Food that are good for you, the farmer and the environment. She is now an ambassador for Smart Food, and has developed five millet, sorghum and groundnut-based recipes created by her label 'Aistou Cuisine' and shared them through her social media. The target of this campaign was mainly men and women living in West Africa, but she was able to reach out to more audiences in Europe, including communities based in France. "Given that these crops are mostly neglected, it was necessary to think of new recipes or revisit some ways of transforming the raw materials of these smart crops. We came up with innovative recipes while at the same communicating how to derive the best from the nutritional benefits of Smart Food," Aissatou explains.

Once this choice was made, it was necessary to build the editorial content around these recipes and publish them on the blog Aistou Cuisine to explain in detail their preparation and nutritional benefits. This led to the launch of the Smart Food social media campaign from 12 October to 27 December 2017, which saw a staggering reach of 473,222 viewers, generating more than 800,000 comments and feedback. Apart from arousing curiosity about the crops, it led to the generation of queries on where to find these grains.

The blogger and the ICRISAT team were able to guide viewers on where to find millets and sorghum grains in shops in Europe. "In West Africa, especially in Mali and Senegal, the new recipes saw many viewers eager to try out the novel ways of cooking and consuming millets and sorghum,"says Ms. Agathe Diama, Head Regional Information and Smart Food coordinator –West and Central Africa. A survey conducted in December 2017 showed that the videos of the five recipes promoted online registered 85,657 minutes (1,428 hours) of viewving time. 'Even though the official social media campaign has ended, interactions continue around the videos and articles published in the blog," says Aissatou M'baye.

This interest has spurred more smart food initiatives that are in the pipeline. These incude strengthening culinary research and testing, engaging and working with research institutes (food and nutrition laboratories), universities (in Africa, Europe and America), schools (school feeding program) and health experts (to enhance mother and infant nutrition).

It is essential to sensitize rural communities to dietary diversity and the nutritional value and health benefits of Smart Food through innovative behavior change communication approaches while parallelly working with key influencers. "We will continue with our social media campaigns, Smart Food television reality cooking show and raise champions who will spread the word on how Smart Food recipes aid diversification of diets," adds Agathe Diama, who strongly believes that partnerships is the way to go to improve nutrition in rural and urban areas in the Sahel.

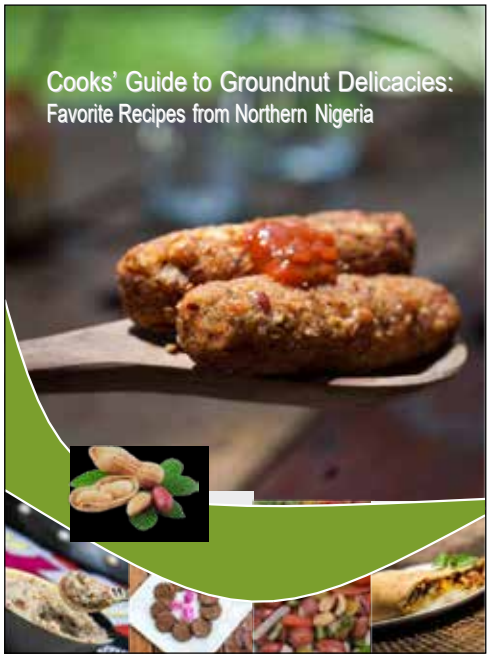
Cook's Guide on groundnut opens up pathways to boost consumption in Nigeria

Hajiya Binta (center), wife of Katsina state Governor takes a close look at the groundnut-based products during the launch.

In 2017, ICRISAT partnered with Catholic Relief Services (CRS) and Women Farmers Advancement Network (WOFAN) to launch a Cook's guide on groundnut. The guide comprises 16 different ways of incorporating groundnut into local diets and highlights the nutritional and health benefits of consuming each product.

Groundnut, a Smart Food (http://www.icrisat.org/smartfood), provides energy and essential nutrients such as protein, phosphorous, thiamin and niacin, key to fighting the scourge of hidden hunger (http://www.fao.org/about/meetings/icn2/news/news-detail/en/c/265240). Over 80% (2.2 out of 2.5 million) of the severely malnourished children in Nigeria are in the northern region. Considering that Nigeria is home to the highest number of stunted children on the African continent and ranks third globally, with more than 10 million stunted children, this guide is a handy reference source to address the challenges of malnutrition.

Tasting the products during the launch in Kebbi state.



What you need

- Fried, crushed groundnut or groundnut butter: 2 cups
- Flour: 8 cups (Alternatively, 7 cups of flour + 1 cup of groundnut powder)
- Sugar: 3 cups
- Butter: 5 cups
- Eggs: 20
- Flavor: 1 bottle
- Baking powder: 2 tsp

Method

- Cream sugar and butter together till soft and fluffy.
- Add ½ a bottle of the flavor and beat.
- Add eggs and rest of the flavor and beat till smooth.
- Add the flour.
- Beat in groundnut butter to a soft consistency.
- Pour into oiled cake pan and bake at 350°C for 15 minutes.

Project: Increasing Groundnut Productivity of Smallholder farmers in Ghana, Mali and Nigeria (2015-2018)

Funding: United States Agency for International Development (USAID)

Partners: Institute for Agricultural Research/Ahmadu Bello University, Zaria (IAR/ABU), Centre for Dryland Agriculture/Bayero University, Kano (CDA/BUK), National Agricultural Seeds Council (NASC), Federal University of Agriculture, Markudi (FUAM), Green Sahel Agricultural and Rural Development Initiative (GSARDI), Catholic Relief Services (CRS), Women Farmers Advancement Network (WOFAN), Agricultural Development Authorities/Projects of Jigawa, Kano, Katsina, Kebbi and Sokoto States.

Scientific recognition

Research achiever:
Dr Djeneba Konaté

Promising Young Scientist:
Dr Baloua Nebie

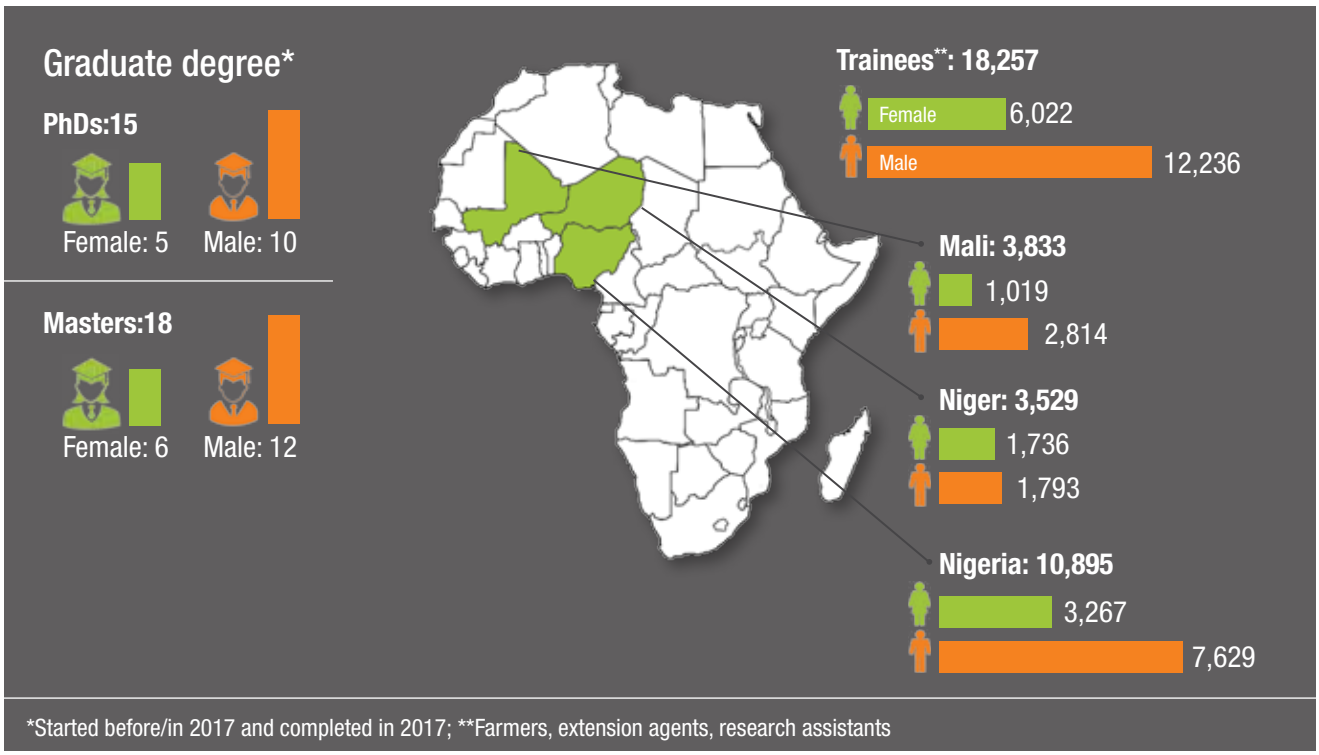
Best scientific article: **Robert Zougmoré, Mathieu Ouédraogo, Samuel T Partey**

Intergovernmental Panel on Climate Change (IPCC) (http://www.ipcc.ch) global climate change Scholarship for PhD student working in Millet breeding program, Niamey: September 2017 (Awarded to Dr Prakash Gangashetty for student Hassane Zakari).

New Grants

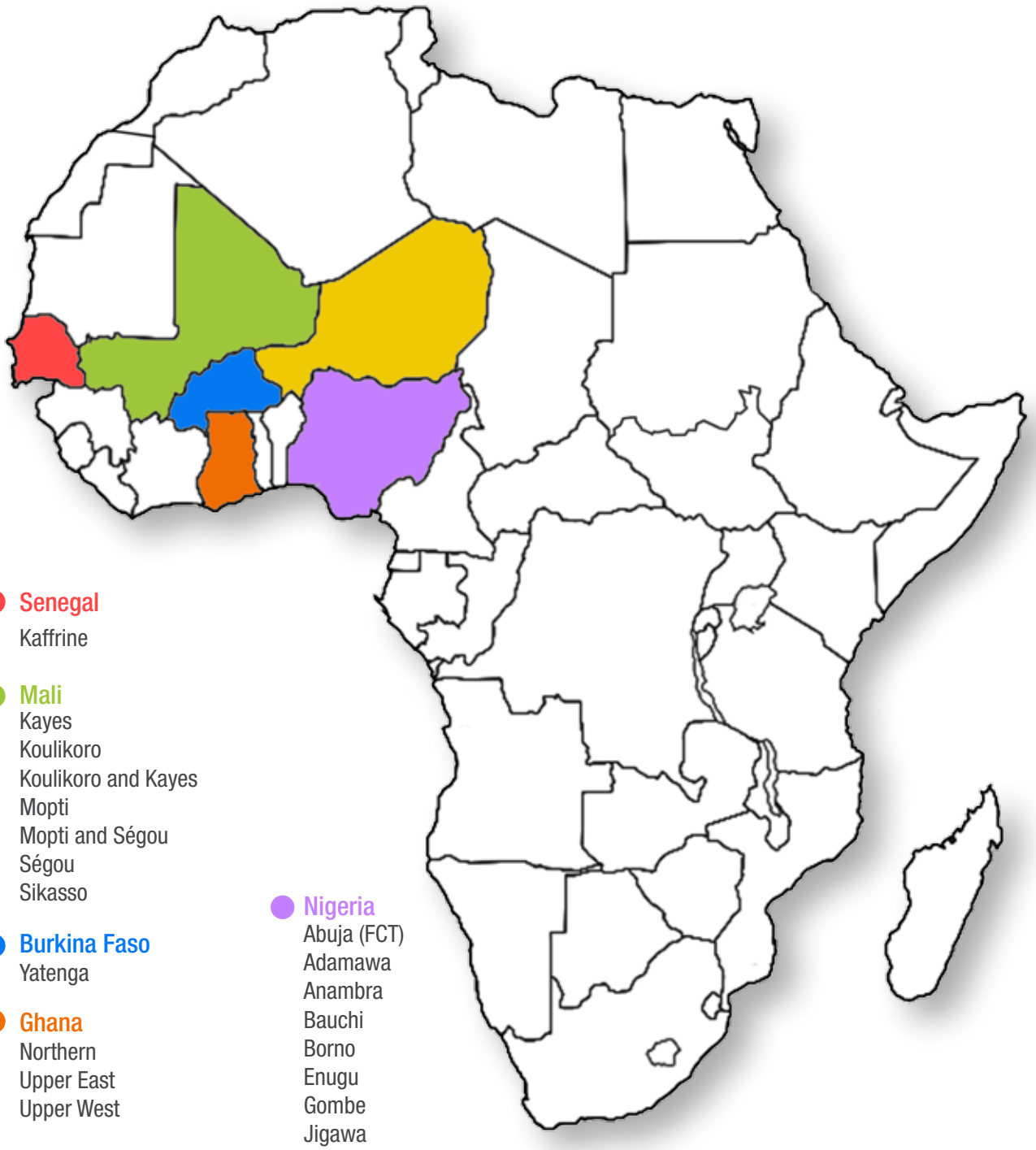
USAID-Mali thru World Bank; IFPRI/CIAT -HarvestPlus; FAO; SPACEBEL, Belgium; and EU-Niger.

Capacity building



*Started before/in 2017 and completed in 2017; **Farmers, extension agents, research assistants

Where we work



Senegal
Kaffrine

Mali
Kayes
Koulikoro
Koulikoro and Kayes
Mopti
Mopti and Ségou
Ségou
Sikasso

Burkina Faso
Yatenga

Ghana
Northern
Upper East
Upper West

Niger
Diffa
Dosso
Maradi
Tahoua
Tillabéry
Zinder

Nigeria
Abuja (FCT)
Adamawa
Anambra
Bauchi
Borno
Enugu
Gombe
Jigawa
Kaduna
Kano
Katsina
Kebbi
Sokoto
Taraba
Yoba

ICRISAT research team in West and Central Africa

Burkina Faso:1 Ghana:1 Senegal:3 Nigeria: 20 Niger: 46 Mali: 83

Scientific staff

Mali

Ramadjita Tabo

Research Program Director – West and Central Africa and Country Representative, Principal Investigator - HOPE ll, Mali

Robert B Zougmore

Regional Program Leader – CCAFS

Aboubacar Toure

Senior Scientist – Sorghum Breeding

Ayoni Ogunbayo

Country Project Manager, Mali – USAID Project

Birhanu Zemadim Birhanu

Senior Scientist – Land and Water Management (WCA)

D Hailemichael Shewayrga

Senior Scientist – Groundnut Breeding

Issoufou Kapran

Senior Scientist – Seed System Specialist

Mathieu Ouedraogo

Senior Scientist – Participatory Action Research (CCAFS)

Samuel Tetteh Partey

Scientist – Climate Change, Agriculture and Food Security (CCAFS)

Felix Badolo

Scientist – Agricultural Economics

Hippolyte Affognon

Senior Project Manager and Technology Uptake Specialist, USAID Project

John Rusagara Nzungize

Senior Project Manager and Technology Uptake Specialist

Agathe Diama

Head – Regional Information

Baloua Nebie

Scientist – Sorghum Breeding

Amadou Bila Belemgoabga

Manager – Administration

Hamado Tapsoba

Regional Coordinator – HOPE ll and TL lll

Yila Jummai Othniel

Scientist – Gender Research

Lilian Nkengla

Visiting Scientist – Gender Research

Nadine Worou

Program Officer

Amadou Sidibe

Special Project Scientist

Bouba Traore

Scientist – Knowledge Broker

Niger

Malick Niango Ba

Country Representative

Boubie Vincent Bado

Principal Scientist – Dryland Systems and Livelihood Diversification

Fatondji Dougbedji

Senior Scientist – Agronomy

Falalou Hamidou

Regional Scientist – Physiology

Prakash I Gangashetty

Scientist – Pearl millet breeding

Hassane Amadou

Regional Finance Manager

Nigeria

Hakeem Ajeigbe

Country Representative

Ijantiku Ignatius Angarawai

Senior Scientist – Sorghum Breeding

Michael Boboh Vabi

Country Project Manager

Shuaibu Abubakar Ummah

Monitoring and Evaluation (M&E) Specialist

Folorunso Mathew Akinseye

Post-doctoral fellow

Senegal

Issa Ouedraogo

Project Coordinator – Climate Services (CCAFS)

Ndeye Seynabou Diouf

Manager – Monitoring & Evaluation (CCAFS)

Pierre CS Traore

In – Business Researcher (Secondment)

Ghana

Paul Tanzubil

Country Project Manager, Ghana – USAID Project

Burkina Faso

Myriam Adam

Systems agronomist

PUBLICATIONS

Crop Improvement

Desmae H and Sones K. 2017. Groundnut cropping guide. Africa Soil Health Consortium, Nairobi. CAB International.

http://oar.icrisat.org/10832/

Gregorio E B, Orozco-Arroyo E, Eleonora G, Cominelli E, Gangashetty P I, Stefania Grando S, Zu T T K, Daminati M E, and Nielsen G, Sparvoli F. 2018. Antinutritional factors in pearl millet grains: phytate and goitrogens content variability and molecular characterization of genes involved in their pathways. PloS one, 13 (6) : 1-30.

http://oar.icrisat.org/10748/

Hamidou F, Awel M S, Bissala Y H, Falke A B and Upadhyaya H D. 2017. Abiotic stresses tolerance and nutrients contents in groundnut, pearl millet and sorghum. Mini core germplasm for food and nutrition security. Indian Journal of Plant Genetic Resources 30: 201-209.

http://oar.icrisat.org/10404/

Kante M, Rattunde H F W, Leiser W L, Diallo B, Diallo A, Touré A, Nebié B, Weltzien E, and Haussmann B I G. 2017. Can tall Guinea-race sorghum hybrids deliver yield advantages to smallholder farmers in West and Central Africa? Crop Science 57:1-10.

http://oar.icrisat.org/9882/

Varshney R K, Shi C, Thudi M, Mariac C, Wallace J, Qi P, Zhang H, Zhao Y, Wang X, Rathore A, Srivastava R K, Chitikineni A, Fan G, Bajaj P, Punnuri S, Gupta S K, Wang H, Jiang Y,,Couderc M, Katta M A V S K, Paudel D R, Mungra K D, Chen W, Harris-Shultz K R, Garg V, Desai N, Doddamani D, Kane N A, Conner J A, Ghatak A, Chaturvedi P, Subramaniam S, Yadav O P, Berthouly-Salazar C, Hamidou F, Wang J, Liang X, Clotault J, Upadhyaya H D, Cubry P, Rhoné B, Gueye M C, Sunkar R, Dupuy C, Sparvoli F, Cheng S, Mahala R S, Singh B, Yadav R S, Lyons E, Datta S K, Hash C T, Devos K M, Buckler E, Bennetzen J L, Paterson A H, Ozias-Akins P, Grando S, Wang J, Mohapatra T, Weckwerth, Wand Reif J C, Liu X, Vigouroux Y, and Xu X. 2017. Pearl millet genome sequence provides a resource to improve agronomic traits in arid environments. Nature Biotechnology : 1-13.

http://oar.icrisat.org/10183/

Integrated Crop Management

Baoua I B, Ba M N, Amadou L, Kabore C, and Dabire-Binso C L. 2018. Field dispersal of the parasitoid wasp *Habrobracon hebetor* (Say) (Hymenoptera: Braconidae) following augmentative release against the millet head miner *Heliocheilus albipunctella* (De Joannis) (Lepidoptera: Noctuidae) in the Sahel. Biocontrol Science and Technology 28 (4) : 404-415. https://doi.org/10.1080/09583157.2018.1450842

http://oar.icrisat.org/10528/

Kabore A, Ba N M, Dabire-Binso C L, and Sanon A. 2017. Field persistence of *Habrobracon hebetor* (Say) (Hymenoptera: Braconidae) following augmentative releases against the millet head miner, *Heliocheilus albipunctella* (de Joannis) (Lepidoptera: Noctuidae), in the Sahel. Biological Control 108 : 64–69.

http://oar.icrisat.org/9972/

Sangare G, Doka D I, Baragé M, and Fatondji D. 2017. Impact of previous legumes on millet mycorrhization and yields in sandy soil of West African Sahel. Journal of Soil Science and Environmental Management 8(10): 164-189. DOI: 10.5897/JSSEM2017.0647

http://oar.icrisat.org/10382/

Systems Analysis and Policy & Impact

Abdullahi A, Jarial S, Jibrin M J, and Ajeigbe H A. 2017. Gender analysis on food consumption patterns for enhancing food security in Nigeria. International Journal of Agriculture Innovations and Research. Volume 5, Issue 6, ISSN (Online) 2319-1473.

http://oar.icrisat.org/10862/

Andrieu N, Sogoba B, Zougmore R, Howland F, Samake O, Bonilla-Findji O, Lizarazo M, Nowak A, Dembele C, and Corner-Dolloff C. 2017. Prioritizing investments for climate-smart agriculture: Lessons learned from Mali. Agricultural Systems 154 : 13-24.

http://oar.icrisat.org/9962/

Bayala J, Zougmoré R, Dayamba S D, and Olivier A. 2017. Editorial for the thematic series in agriculture & food security: Climate-smart agriculture technologies in West Africa: learning from the ground AR4D experiences. Agriculture & Food Security 6:40.

http://oar.icrisat.org/10351/

Buah S S J, Ibrahim H, Derigubah M, Kuzie M, Segtaa J V, Bayala J, Zougmore R, and Ouedraogo M. 2017. Tillage and fertilizer effect on maize and soybean yields in the Guinea savanna zone of Ghana. Agriculture & Food Security 6: 17.

http://oar.icrisat.org/10153/

Falconnier G, Descheemaeker K, Van Mourik T A, Adam M, Sogoba B, and Giller K E. 2017. Co-learning cycles to support the design of innovative farm systems in southern Mali. European Journal of Agronomy 89 : 61-74. http://dx.doi.org/10.1016/j.eja.2017.06.008

http://oar.icrisat.org/10087/

Hakeem Ayinde Ajeigbe, Babu Nagabushan Motagi, Shiyanbola Abiodun Abdulsalam. 2017. Response of Irrigated Groundnut to Polythene Mulching on Broad Bed and Furrows during the Low Temperature Months in Nigeria. International Journal of Environment, Agriculture and Biotechnology (IJEAB) Vol-2, Issue-5, Sep-Oct- 2017 http://dx.doi.org/10.22161/ijeab/2.5.53.

http://oar.icrisat.org/10238/

Hyman G, Espinosa H, Camargo P, Abreu D, Devare M, Arnaud E, Porter C, Mwanzia L, Sonder K, and Traore S. 2017. Improving agricultural knowledge management: the AgTrials experience. F1000Research 6:317.

http://oar.icrisat.org/10088/

Ng'ang'a, Stanley K, Miller V, Essegbey G, Karbo N, Ansah, V, Nautsukpo D, Kingsley S, and Girvetz E. 2017. Cost and benefit analysis for climate-smart agricultural (csa) practices in the coastal savannah agro-ecological zone (aez) of Ghana. International Center for Tropical Agriculture CIAT, USAID. Cali.CO. 50 pp.

https://cgspace.cgiar.org/handle/10568/83464

Ouédraogo M, and Dakouo D. 2017 (French). Evaluation de l'adoption des variétés de riz NERICA dans l'Ouest du Burkina Faso. African Journal of Agricultural and Resource Economics 12 : 1-16.

http://oar.icrisat.org/10113/

Palazzo A, Vervoort J M, Mason-D'Croz D, Rutting L, Havlík P, Islam S, Bayala J, Valin H, Kadi H A K, Thornton P, and Zougmore R. 2017. Linking regional stakeholder scenarios and shared socioeconomic pathways: quantified West African food and climate futures in a global context. Global Environmental Change 45: 227-242.

http://oar.icrisat.org/10255/

Partey S T, Zougmore R B, Ouédraogo M, and Thevathasan N V. 2017. Why promote improved fallows as a climate-smart agroforestry technology in Sub-Saharan Africa? Sustainability 9: 1887.

http://oar.icrisat.org/10262/

Partey S T, Zougmoré R B, and Ouédraogo M. 2017. Climate information use implications for climate risk mitigation in West Africa. Special issue on climate-smart agriculture (CSA). Agriculture for Development no. 30 : 16-17.

http://oar.icrisat.org/10714/

Sidibe A, Totin E, Thompson-Hall M, Schmitt-Olabisi L, and Traore P C S, 2017. Multi-scale governance in agriculture systems: Interplay between national and local institutions around the production dimension of food security in Mali. NJAS - Wageningen Journal of Life Sciences 84:94-102.

http://oar.icrisat.org/10391/

Somda J, Zougmoré R, Sawadogo I, Bationo B A, Buah S, and Abasse T. 2017. Adaptation processes in agriculture and food security: Insights from evaluating behavioral changes in West Africa. Pages 255-269 *in* Evaluating climate change action for sustainable development (Uitto, J., Puri J., and van den Berg R., eds.). Springer, Cham.

http://oar.icrisat.org/9860/

Sova C A, Thornton T F, Zougmore R, Helfgott A, and Chaudhury A.S. 2017. Power and influence mapping in Ghana's agricultural adaptation policy regime. Climate and Development 9 : 399-414.

http://oar.icrisat.org/10335/

Traore K, Sidibe D K, Coulibaly H, and Bayala J. 2017. Optimizing yield of improved varieties of millet and sorghum under highly variable rainfall conditions using contour ridges in Cinzana, Mali. Agriculture & Food Security 6:1-13.

https://agricultureandfoodsecurity.biomedcentral.com/articles/10.1186/s40066-016-0086-0

Vadez V, Halilou O, Hissene H M, Traore P S, Sinclair T R, and Soltani A. 2017. Mapping water stress incidence and intensity, optimal plant populations, and cultivar duration for African groundnut productivity enhancement. Frontiers in Plant Science 8:432 (Agroecology and Land Use Systems). DOI=10.3389/fpls.2017.00432.

http://oar.icrisat.org/10073/

Upscaling Proven Technologies

Adinoyi A, Ajeigbe H A, Angarawai I I, and Kunihya A. 2017. Effect of grain moisture content on the physical properties of some selected sorghum varieties. International Journal of Scientific & Engineering Research 8.6 (2017): 1796-1805.

http://oar.icrisat.org/10122/

Akinseye F M, Adam M, Agele S O, Hoffmann M P, Traore P C S, and Whitbread A M. 2017. Assessing crop model improvements through comparison of sorghum (*sorghum bicolor* L. moench) simulation models: A case study for West African varieties. Field Crops Research 201:19-31. http://dx.doi.org/10.1016/j.fcr.2016.10.015

http://oar.icrisat.org/9818/

Angarawai I, Ajeigbe H A, Umar H, Gaya, and Yeye M. 2017. Effect of heat stress on seed production of some sorghum varieties under irrigation in Northern Nigeria. Research Journal of Agriculture 4 (8) :1-5.

http://oar.icrisat.org/10374/

Eche C O, Vabi M B, Ekefan E J, Ajeigbe H A, and Ocholi F A. 2017. Evaluation of different fertilizer sources for the management of aflatoxin contamination in groundnut (*Arachis hypogaea* L.) in the Southern Guinea Savannah agro-ecological zone of Nigeria. International Journal of Advanced Research 5 (11): 967-976.

http://oar.icrisat.org/10350/

Dawud M A , Angarawai I I, Tongoona P B, Ofori K, Eleblu J S Y, and Ifie B E. 2017. Farmers' production constraints, knowledge of Striga and preferred traits of pearl millet in Jigawa State, Nigeria. Global Journal of Science Frontier Research: D Agriculture and Veterinary 17 (3) :1-7.

http://oar.icrisat.org/10375/

Tanzubil P B, and Yahaya B S. 2017. Assessment of yield losses in groundnut (*Arachis hypogaea* L.) due to arthropod pests and diseases in the Sudan savanna of Ghana. Journal of Entomology and Zoology Studies 5 (2): 1561-1564.

http://oar.icrisat.org/10091/