SARD-SC

Support to Agricultural Research for Development of Strategic Crops in Africa

IITA
Transforming African Agriculture

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ANNUAL REPORT 2016

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IITA Ibadan, Nigeria
Telephone: (234-2) 7517472
Fax: +44 208 7113786
E-mail: iita@cgiar.org
Web: www.iita.org

To Headquarters from outside Nigeria:
IITA, Grosvenor House, 125 High Street
Croydon CR0 9XP, UK

Within Nigeria:
PMB 5320, Oyo Road
Ibadan, Oyo State

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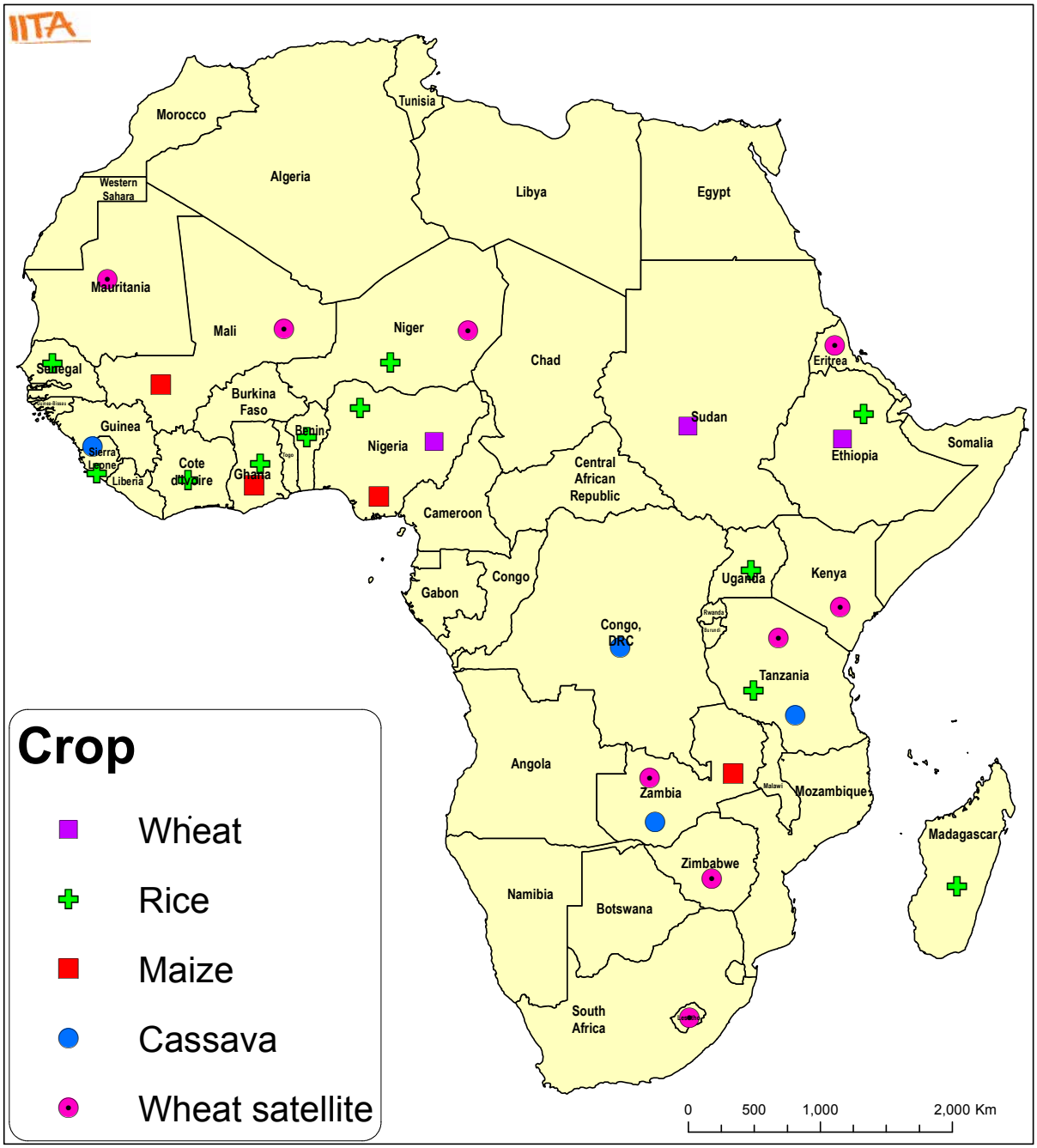


From the SARD-SC Project Coordinator

Dr Chrys Akem

Once again, it is my pleasure to present to you the fourth Corporate Annual Report of the Multinational CGIAR project ***"Support to Agricultural Research for Development of Strategic Crops in Africa" (SARD-SC).*** This project is funded by the African Development Bank (AfDB) and implemented under the leadership of the International Institute of Tropical Agriculture (IITA). In this Report we focus on a few of the project achievements from last year that have been effectively implemented across the four commodity value chains.

Though the project will be winding down in the next few months, we are proud of what we have been able to accomplish since the inception of the program. This is technically the fourth year of project implementation, and some notable achievements and impacts from the project are already clearly visible in some of the focused RMCs. But it has not been a smooth sail for a complex project that involves four commodities (cassava, maize, rice, and wheat), four CGIAR institutions (IITA, ICARDA, AfricaRice, and IFPRI), and 20 Regional Membership Countries (RMCs) – Benin, Côte d'Ivoire, DR Congo, Eritrea, Ethiopia, Ghana, Kenya, Lesotho, Madagascar, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Sudan, Tanzania, Uganda, Zambia, and Zimbabwe.

In this edition, we are taking stock of the achievements and impact the project has made in the respective value chains. In project countries, cassava value chain activities have been taken to a commendable height in the areas of value addition, varietal increases, and agronomic advances. This cannot be ignored by participating countries' governments who are partnering with the SARD-SC project to further disseminate the impact the project is making to smallholder farmers and the ordinary people of those countries. For example, Project activities in Zambia and Sierra Leone have been commended by the governments of these countries for the increased productivity of cassava. As a result, a Zambian Brewery has engaged local cassava farmers to supply the crop as a raw material to produce Eagle beer. Youth are working on large hectares of land planting cassava to serve as a raw material to the many processing centers in Sierra Leone. In this report we give the highlights of how the project has facilitated the important role cassava is playing in the life of the ordinary farmer to enhance food security and reduce poverty.

The maize value chain of the project focuses on how to accelerate its transformational impact in the target project countries – Nigeria, Ghana, Mali, and Zambia. Here, we see all the various steps being taken to achieve this transformational impact by analyzing the constraints faced by rural and smallholder farmers, how to enhance maize grain for stress tolerant varieties, improving agronomic practices, and doubling density fertilizer demonstrations as well as many more activities to raise maize productivity. This section also throws more light on the steps taken by the maize value chain to forge strong market linkages for the benefit of local farmers for maize bulk commodity marketing to engender good and competitive prices and link them to big time off-takers.

The focus of the rice value chain is on the introduction and manufacture of farm machinery prototypes to ease labor on farm and postharvest operations and at the same time improve the quality of the products. Impressive technologies and innovations generated to reduce drudgery among farmers and improve quality of rice are a good read. We see the analysis of various equipment tested and locally fabricated for weeding, planting, and parboiling, and others that have helped to improve rice quality and production. Capacity building activities which are also an integral part of this project implementation are highlighted in this value chain.

In the last edition of the annual report, we shared the success story of the wheat commodity value chain making it into the Nigerian agricultural transformation commodity list because of demonstrated high yields of adapted wheat varieties evaluated and selected across locations through the project. Enhancing wheat competitiveness through developing and deploying high heat-tolerant and disease-resistant wheat varieties in Africa to foster food security and economic growth and reduce the cost of wheat importation is the focus of the value chain in this section.

We look forward to measurable outcomes of this project in the years ahead and shall continue to update and highlight achievements in the next and last annual edition of this Report. The project shall also continue to build on the successes and achievements of each year as it strengthens partnerships with the RMCs and disseminates the impacts of the public goods from the project, while intensifying efforts to improve the livelihoods of all our stakeholders, especially the youth and smallholder farmers of Africa.

I wish you all an enjoyable read of this fourth report.

Dr Chrys Akem

Cassava value chain

Zambian government officials commend innovation in cassava crop utilization and mechanization

SARD-SC cassava activities in Zambia have been taken to a commendable height which cannot be ignored by the country's government officials. Having done well in the areas of cassava yield increase, varietal increase, and value addition, project activities have been attracting important personalities like never before.

So, when the SARD-SC project, the Zambia Agriculture Research Institute (ZARI), and the innovation platform (IP) actors and cassava stakeholders from around Zambia converged in Mansa District for a cassava open day to communicate some of the achievements the partnership has brought about, high-powered government officials graced the occasion. The guest of honor was Hon. Givens Lubinda, Member of Parliament and Minister of Agriculture in Zambia and his entourage which included Mr Boniface Chimbwali, the Permanent Secretary of Luapula Province, Deputy Director for ZARI Mrs Monde Zulu, CAMAP Director, George Maricheba, the African Agricultural Technology Foundation (AATF) Director, Dr Denis Chitere, and other invited delegates. The program was hosted by one of the key SARD-SC partners, Dr Martin Chiona, who is also a team leader for the Root and Tuber Program at ZARI- Mansa. The guests visited field experiments hosted at Mansa Research Station.

Dr Chiona took time to explain the science behind the cassava program, the partnerships involved, and the scaling out approaches and efforts. Mechanization and value addition of cassava were key demonstrations which were presented to the visitors. The challenge however lies in the multiplication of that one plant into many cuttings. He acknowledged the massive support from the African Development Bank (AfDB) through the SARD-SC project and IITA. The visitors appreciated the strides that have been made in introducing high-yielding and disease-resistant varieties to farmers.

Value addition and utilization

After the field visit, an opportunity was given to showcase the various cassava-based products that can be made from cassava. The SARD-SC Postharvest Utilization Research Assistant was on hand to display mouth-watering delicacies of cassava-based products and these ranged from 20% cassava bread, to cassava cakes, cassava cupcakes, chin-chin, tidbits, cassava coconut biscuits, cassava fingers, cassava egg rolls, cassava fish rolls, cassava doughnuts, and cassava strips (50% cassava and beans).

The products on display were 100% cassava based to the pleasant surprise of the visitors. The guest of honor, who tested various cassava products, commended IITA's and ZARI's efforts through the SARD-SC project which were meant to bring out and realize the potential of cassava as a multipurpose crop. He requested IITA to continue the good work in spearheading the various utilization aspects of cassava. Among the participants were members of two notable women groups the "***Kanakatapa Women's Group***" and the "***Fisuma Fileisa Women's Club***". Members from these groups were beneficiaries of various trainings on products development conducted by the SARD-SC teams. Today these groups earn an income from the preparations of the cassava products which they sell in their locations.

The Minister of Agriculture also tasked IITA to see to it that every mother/farmer in Zambia should be able to use or develop cassava-based product in the manner IITA is doing it.

He encouraged increased participation of the youth in cassava production and also directed his ministry to re-enact the cassava strategy paper with immediate effect. He further hinted on government's plans to introduce policy that would compel millers to start blending wheat flour and cassava flour in bread production. He also noted that government was in discussion with livestock feed millers to start substituting maize for cassava in the production of stock feed.

Mechanization

The Minister also took time to participate in the demonstration of mechanized cassava planting using the Planti Centre planter from Brazil that the SARD-SC project has been promoting through demonstration to farmers in the project intervention areas in Mansa and Kaoma districts. He noted that commercial production needs to be embraced and the hand hoe should be put in the museum where it belongs.

After demonstrating planting of cassava using a mechanical planter, the Minister witnessed cassava harvesting using a tractor drawn harvester. He was informed that the field should be ratooned and the harvester is used in the field to enable the tractor to drive over the crop. The participants were delighted to see that the harvester was able to harvest a large portion of the field in a short period of time. The losses in the form of breakages were minimal and this encouraged the Minister who further appealed to the youth to get involved in the production of cassava in a smart way using mechanized production which is low in drudgery and enjoyable.

Pics 5 & 6: The Minister of Agriculture demonstrating how to plant cassava using a mechanized planter.

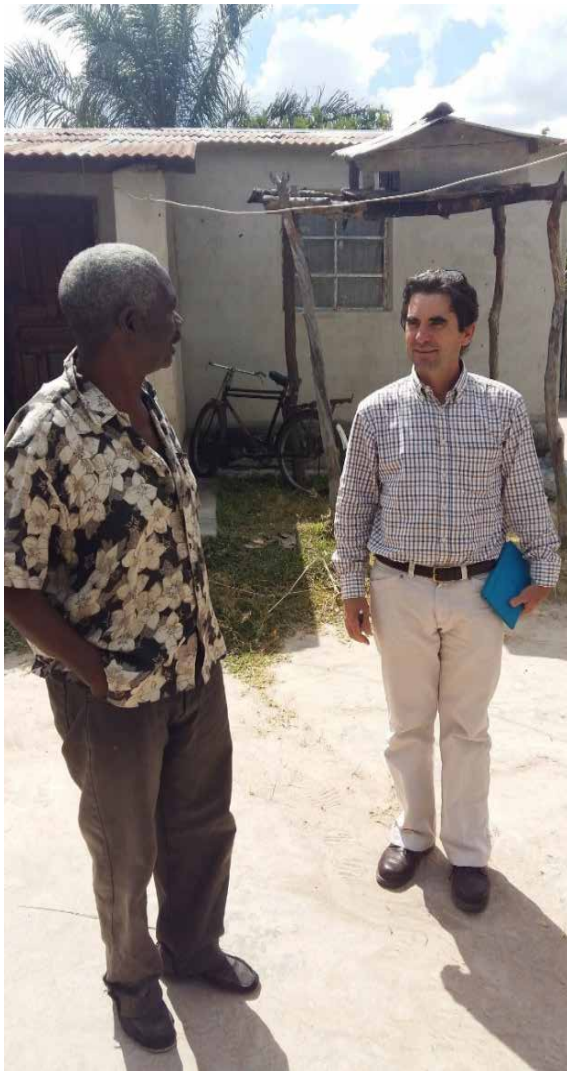
Cassava value chain

Pics 7 & 8: Farmers picking cassava behind a mechanical cassava harvester.

Brewery engages cassava producers as market linkages begin to take shape in Zambia

Luapula Province in Zambia is one of the regions in the country that produces large quantities of cassava. Traditionally cassava is a staple that is consumed in the northern, northwestern, and western provinces of the country. The national average production of cassava in Zambia has increased over the years from 139,000 MT in 1965 to the current 1,260,853 MT in 2013. This steady increase has been as a result of the many interventions that are ongoing in the cassava value chain and one notable innovation is the dissemination of improved cassava varieties, high yielding to smallholder farmers.

The SARD-SC project used Innovation platforms (IPs) not only to disseminate technologies but also to link farmers to the market. Through the IP approach, farmers in Mansa District of Luapula Province have been linked to Zambia Breweries, a subsidiary of SABMiller South Africa which intends to start using the starch from cassava as the main ingredient for one of its brand beverages, the "Eagle Lager" beer. Through protracted discussions on quality, quantity, and price of cassava with the IP chairperson, Zambia breweries has engaged an agent to procure cassava chips from the farmers.



a) *Mansa IP Chairperson (left) engages in a discussion with Zambia Breweries Agribusiness Manager (right)*

b) Women prepare cassava chips in readiness for delivery to Zambia

c) Bags packed and ready for pickup in Mansa

Cassava farmers in Luapula region have welcomed this market linkage to Zambia Breweries and have since begun preparing cassava chips for delivery. It is expected that this linkage will in the long term, drive the production of cassava up as the demand for the cassava chips increases which is currently at 1600 MT from SABMiller.

The Mweru improved cassava variety which is being promoted has been accepted overwhelmingly both by Zambia Breweries and the farmers owing to its high yielding potential and its resistance to pest and diseases. Zambia Breweries has expressed its gratitude to the SARD-SC project and wishes to continue engaging more farmers working with IITA through IPs. Further, SABMiller has every intention of offering premium prices to farmers who will produce the improved varieties away from the disease prone local varieties.

Sierra Leone

SARD-SC project empowers youth to establish large farms to supply raw materials to community cassava processing centers in Sierra Leone

Nineteen (19) community cassava processing centers owned and managed by Community Based Organizations (CBOs) have been supported by the SARD-SC project from 2012 to till date. Support by the project for the country's agriculture sector has been focused on cassava value chain development and promotion in 10 out of 12 agricultural districts targeting smallholder cassava processing centers. This is in collaboration with the Sierra Leone government in the implementing of its National Sustainable Agricultural Development Policy (NSADP) and the Small-holder Commercialization Project (SCP) led by the Ministry of Agriculture, Forestry and Food Security (MAFFS). Young women and men in rural communities are the driving force behind the progress achieved so far.

Through the concerted efforts of the government, IITA, and other partners, cassava value chain promotion has benefited farmers, processors, and marketers who are earning additional income from engaging in cassava value chain work. The youth form the bulk of the population in rural communities and they provide the energy required for producing and sustaining the supply of raw materials (cassava

Women led cassava production group at their farm site: Blama, East Sierra Leone

Youth led cassava production group with their community leader in a festive mood on their farm during an official visit: Mokamatipa, South Sierra Leone

roots) to these newly established cassava processing centers. Youths have realized that they can create their own niche in cassava root production for raw material supply to the processing centers.

A youth cassava grower scheme is being piloted this year by SARD-SC project in partnership with youth groups from four community cassava processing factory locations (one each in Gbaama, Kailahun district; Largor, Bo district; Massahun Fortune, Pujehun district; and Mabarr, Tonkolili district). This partnership was triggered by the desire of the youth (aged 18–35 years) for needed empowerment skills in best-bet cassava agronomic practices to sustainably reap high-quality improved root and seed material every season and the desire to establish linkages among growers and processors to supply raw material to processing factories for income generation for themselves.

In the Memorandum of Agreement between the SARD-SC project and the youth, both parties have agreed on the following:

Youth Group

- Select group membership of 20 (10 women and 10 men aged 18–35 years) from each community.
- Ensure group members are aware of the motives for forming the group and register as members, develop and agree on a code of conduct binding the group together.
- Agree on a governance structure for the group, hold elections for elective positions with gender parity.
- Register the group with the Ministry of Agriculture, Forestry and Food Security (MAFFS), the Ministry of Social Welfare, Gender and Children's Affairs (MSWGCA), and the district local council for recognition at local and national levels of government.
- Provide necessary labor and be responsible and carry-out the following operations on their farm, i.e., land preparation, planting, weeding, and harvesting.
- Provide support to processing centers.
- Provide local services for other farmers in the innovation platform.
- Promote SARD-SC project activities in their locality.

IITA/SARD-SC Sierra Leone is expected to provide the following:

- Make improved cassava planting varieties available to the group at the time of planting.
- Provide hands-on-training in best-bet management practices for cassava production, business/entrepreneurial skill development, and marketing of roots.
- As the opportunity avails itself, play an advocacy role in soliciting support from donor agencies to provide support for youth activities.
- Support group participation at agricultural shows and farmer-to-farmer visits.

So far, youth groups have embarked on the following:

a. brushing of farm land

b. Clearing of farm land for planting

c. Sourcing and delivery of improved cassava planting material for youth farms

d. Preparing cassava planting stakes for planting

e. Acquiring training in best-bet planting techniques for cassava

a. Brushing of farm land

Youth brushing farm sites for cassava root production.

b. Clearing of farm land for planting

A cleared farm by youth ready for planting at Mabarr.

c. Sourcing and delivery of improved cassava planting material for youth farms

Improved cassava planting materials from CBO managed multiplication farm.

Transporting improved cassava planting materials to youth farm sites

Cassava value chain

d. Preparing cassava planting stakes for planting

Youth receiving and cutting stakes for planting on their farms

e. Acquiring training in best-bet planting techniques for cassava

Cutting stakes for planting.

Demonstrating how to plant cut stakes in the soil.

Row planted cassava field in demo plot.

Location of youth group	Membership		Area brushed and cleared (ha)	Area planted (%)	Support from SARD-SC project (Bundles of improved cassava planting material)*
	Male	Female			
Gbaama	15	10	3.9	100	250
Largor	15	10	4.2	100	200
Mabarr	10	10	3.6	100	250
Massahun Fortune	17	12	0.65	60	60

*1 bundle = 50, one-meter-long sticks.

A total of 99 youth (57 men and 42 women) have registered to take part in the cassava production scheme from four rural communities. Across the four communities, 12.35 ha have been planted with 760 bundles of improved cassava planting material supplied by the project.

There have been many challenges in getting the farms up and running. However, the youth are determined to succeed against all odds and with this resolve, the following outputs have been achieved so far in the season:

SARD-SC will soon follow up with a comprehensive hands-on training for the youth in best-bet integrated management practices at their farm sites.

Project boosts cassava yield by introducing improved varieties and best agronomic practices in Kpatema

Through collaboration with the Our Lady of the Holy Rosary Catholic Church, the Kpatema women, Catholic Women Association, Bo diocese, the IITA/SARD-SC project established a cassava demonstration farm in Kpatema to showcase the impact of organic manure (PKcake), soil tillage practice on three cassava varieties including a local cassava variety (control variety) at the farm site last year.

The 14 hectare cassava farm was planted and managed by the Kpatema women with technical supervision by MAFFS and the IITA/SARD-SC project. The project also established a 2.02 hectare multiplication plot of SLICASS 6 and SLICASS 7 (for dissemination to other farmers) and a demonstration farm showcasing the effect of organic fertilization and soil tillage on the growth of cassava.

A team from the International Institute of Tropical Agriculture (IITA) and a key member of the Sewa Innovation Platform Dr Charles Dixon, Soil Scientist at Njala University, School of Agriculture, Sierra Leone conducted a tour of the Kpatema Women farm site and their cassava processing facility at Kpatema village where the women showcased their improved cassava varieties of SLICASS 4, SLICASS 6, and SLICASS 7 and their newly constructed cassava processing factory funded by CAFOD.

Meanwhile, the group had received loads of bundles of the improved cassava varieties through IITA/SARD-SC support backed up with training on best-fit cassava planting techniques to enhance best crop performance in the field.

Giving a brief overview on the establishment of the 14 ha cassava plantation, the Reverend Sister Bernadette Ezebessa of Our Lady of the Holy Rosary said the project was born out of the eagerness of the women of the Mission and the Catholic Women's Association to embark on agriculture, even when there were not enough funds to make their dream a reality.

At the initial stage she said they had a hundred and fifty women, with limited planting materials for them. With the help of IITA they can now boast of having three hundred women all engaged in the farm, active in cassava production and processing at the factory.

"The intervention of IITA has had huge impact on our activities", she said, for which she reiterated that at the commencement of their operation at Kpatema Village, they only utilized five hectares of fully cultivated cassava plantation, but with the intervention of IITA, that they can now boast of having over 14 ha of cassava under cultivation with SLICASS 4, SLICASS 6, and SLICASS 7 elite varieties.

Sylvanus Fannah, the IITA/SARD-SC project Natural Resource Manager/Agronomist, indicated that the key challenges faced by the Kpatema women at the initial stages included the exorbitant cost of cassava roots in the local market for gari processing, access to improved high yielding cassava varieties, and a capacity vacuum in value chain processing for value addition, marketing, and entrepreneurial skills.

"We then advised that they establish their own production farm where they will be trained in best cassava production practices and in their processing factory assist them in acquiring product development skills including, packaging, and business development and management", Mr. Fannah explained.

Commenting on research undertakings at the farm site, Mr Charles Dixon (Soil Scientist from Njala University) highlighted that farmers all over the country treat cassava with very little attention and care, thereby resulting in low yield at the end of the season.

He indicated that the performance of the cassava crop in terms of root and leaf yield were directly related to available nutrients and levels in the soil where it is growing. "Tillage practice and organic manure fertilization as recommended good management practices, became their first priority at the Kpatema farm site", he explained.

The SARD-SC Cassava Commodity Specialist, Dr Marie Yomeni (first from right) in discussion with Sister Bernadette during the tour of the Kpatema women cassava farm.

Dr Charles Dixon (right), explaining to the Cassava Commodity Specialist (left) how fertilizers were applied to different plots.

"At the initial stage of our intervention", Dr Dixon said, "Kpatema women never saw the need for collaboration involving the use of fertilizers to produce cassava, and the farmers having followed every stage of crop growth under demo at this farm site are excited over what they are seeing and the importance of the practices".

As a soil scientist, he said he was satisfied with the tillage practice so far on the farm, while stating that even though they have entered the dry season, the crops had proven to be very very responsive.

Neomi Bundu is the Field Coordinator for the Catholic Women Association for Kpatema women, she said from the beginning of their engagement in the agricultural project, access to large quantities of improved planting materials, and knowledge on good methods of producing and processing cassava roots into diverse products for market was a challenge. "We had no in-depth knowledge on cassava production and processing" she acknowledges, while noting that the intervention of IITA would forever be viewed as a blessing for our groups' operations.

Neomi Bundu is the Field Coordinator for the Catholic Women Association for Kpatema women

Our skills in producing cassava in the right manner, weeding the crop at the right time, and managing the crop in the field as whole and processing methods to increase value addition are major assets that have been imparted to us by this institution, she concluded.

The Cassava Commodity Specialist for the SARD-SC project Dr Marie Octavie Yomeni, classed Kpatema village as one that is very much friendly, and promised to maintain cordial relations that had already been created between her institution and the membership of the Kpatema Women's group, as cassava growers, processors, and their sponsors.

Tanzania

Project contributes to improving livelihoods of smallholder farmers in Tanzania

Cassava is grown in almost all agroecological zones of Tanzania and it is basically grown to meet household food requirements. However, in many parts of Tanzania including Kigoma and Zanzibar, the crop also occupies a prominent position in generating income for households in order to reduce poverty and enhance food security in rural areas.

Despite efforts made by cassava smallholder farmers before the inception of the SARD-SC project, the productivity of cassava was generally low rendering cassava farming unprofitable in the project areas. This was attributed to several challenges including the use of low yielding varieties which succumb easily to biotic and abiotic stresses due to limited access to planting materials of improved varieties. Also, limited knowledge on good agricultural practices was equally responsible for poor cassava production and productivity resulting into low income accruing from crop. "I grew cassava for 15 years using local varieties and indigenous knowledge, the combination which resulted into low yields", said Mr. Alex, a farmer in Kigoma Region. He said the value of investment he made in cassava production during that period was not reflected in the output. This was a cry of not only Kigoma farmers but also farmers from other places in the country. "I deserted growing cassava for several years because the varieties I used were highly susceptible to diseases and could harvest almost nothing," said Mr Ismail of Kizimbani, Zanzibar. The profits from cassava were never enough to cater for household needs

Mr. Alex Butobuto on his new motorcycle

Mr. Ismail in his shop

including fees for school going children.

When IITA/SARD-SC began activities in these areas, the situation started to get better after improving farmers' access to high yielding and disease-tolerant varieties and promotion of best-bet agricultural technologies as well as improved processing technologies all through the Innovation Platform (IP) approach. "I embarked on growing the crop again after receiving training on management of pests and diseases and multiplication of healthy cassava cuttings through the SARD-SC project", remarked Mr Ismail. "I decided to get serious about cassava production and multiplication of planting materials for sale to other farmers, a decision I will never regret", he added. A similar remark was heard from Mr Alex. "I used to get not more than 3.5 tons of dried cassava (*makopa*) per hectare until 2013 when IITA through SARD-SC project came and changed this state of affairs".

Mr Alex was astonished at the bumper harvest in the 2014/15 season where he, for the first time in his farming experience, got an average of 9 tons of *makopa* per hectare making a total of more than 45 tons in 5 hectares. "This would, otherwise, not have been possible without the contribution of the SARD-SC project which brought us knowledge on good agricultural practices as well as providing us with planting materials of cassava varieties which are high yielding and tolerant to Cassava Mosaic Disease", he insisted.

Mr Alex and Mr Ismail represent farmers who have benefited from the SARD-SC project. They both have testimonies of how their lives have been impacted by the project. For instance, they both said they managed to purchase motorbikes from cassava income. On his part, Mr Ismail said he saved some of his income and eventually opened a shop, while Mr Alex also used his income to acquire an additional 50 acres of land for expanding his production.

Mr Zamiri, a farmer from Kilombero, Zanzibar had a good story too. He, through cassava income, bought a generator for pumping irrigation water. "The era of using a watering can is over for me. I am now using a pump powered by the generator that I have purchased as a result of my involvement in the project", he said, while giving credit to SARD-SC for this milestone.

Mr. Juma standing outside his house which has electricity

Mr. Zamiri with his generator (right).

Bumbwini women (Tumwambie nini group) in a group photo with some of their products

Mr Maulid Juma is another beneficiary of the SARD-SC project and a farmer who is involved in both cassava multiplication and production. "My income has increased through sales of cassava seed and roots; and I have installed electricity in my house and purchased a television set. I no longer use a lantern and now watch news on my new TV set", said Mr Juma.

…Zanzibar Women empowered through training on processing and selling of cassava products

In Zanzibar, for quite a long time farmers did not realize that the cassava business was a lucrative one. This is because, traditionally, cassava utilization was limited to the use of fresh roots as boiled or roasted and as dried *makopa* for making flour. Even those who went into cassava business traded along those lines (mainly fresh market) due to limited knowledge of cassava product diversification. During the implementation of the project, beneficiaries were trained on cassava processing and new product development. The training became an eye opener to beneficiaries who realized cassava could be processed into many other forms of edible products like cakes, buns, chin-chin, cake, fried cassava, spicy cassava porridge, cassava pilau, and cassava crisps. Several groups of women in Zanzibar were trained and turned this knowledge into a business.

Despite this initiative, these women were faced with challenges of start-up capital (though they started anyway). These included Bumbwini and Kilombero women who decided to start with one product ~~ca~~ssava crisps, which are now commonly known by the natives as *makwaru*. As a result of this pro-activeness, the project supported the women groups by giving them a small amount of seed money. After two months, a follow up was made and there was a noticeable outcome from the business undertaken by the women groups.

The approach used by these beneficiaries differed across locations. At Bumbwini, for instance, the women decided to divide themselves into four sub-groups and named them *Tumwambie nini, Saa njema, Maskini mwenyewe tabu*, and *Tamaa ipo*. Each of these sub-groups got a share of one hundred thousand (TZS 100,000) Tanzanian shillings, equivalent to US$45 and invested in *makwaru*.

Mwanaisha Mohamed and Hijakazi Haidari preparing to make cassava doughnut.

After a month, the groups made profits of TZS 212,000 (US$97), 160,000 (US$73), 90,000 (US$41), and 50,000 (US$23), respectively, making a grand total of TZS 512,000 (US$234) profit. *Tumwambie nini* group used part of their profit to contribute to the cost of fixing the gate of their building which is meant for high quality cassava flour processing.

On the other hand, women at Kilombero started by investing only TZS 190,000 of their seed money and kept the balance of TZS 210,000. Within no time they were able to make a profit of TZS 430,000 (US$196). "We decided to use this profit and the balance to extend our line of business by embarking on production of horticultural crops", said Nachia on behalf of her fellow women.

"The profit enabled us to buy fertilizer and four pipes each of 100 meters for irrigating crops in our newly established horticultural unit and we also continue with the cassava product business", she added. This group prepared 3.25 acres of land for growing water melon, egg plants, green pepper, tomato, and amaranthus. They already have water supply in place and purchased 4 water pipes worth TZS 480,000 (US$219) to facilitate irrigation. "We believe our lives will never remain the same as we are seeing the prospects of what we are doing. Thanks to SARD-SC for getting us moving", concluded Nachia. On the other hand, another women's group called MVIWAKI from Kizimbani is coming up and is now devising a package for their cassava products as they find their way to market.

Testimonies of the women

Mwanaisha Mohammed

Mwanaisha Mohamed, Kijakazi Haidari, and Asia Abubakar all from Bumbwini, Zanzibar say they have no regrets participating in the SARD-SC Project and for being members of the IP. "My income has increased through selling cassava flour and cassava chips", said Mwanaisha. "I have even bought a cellular phone which I would not have been able to afford if it were not for this initiative," she said with a smile. Mwanaisha says she is also able to give money to her children when they go to school and can attend to other family necessities from her income. "I am no longer depending on my husband for everything. I have my own income through which I take care of the family like buying school uniforms and kitchen equipment."

Hijakazi Haidari

She said all matters which required money were previously left in the hands of her husband. "The project has earned me respect as I can address some of the family issues which require cash", boasted Kijakazi.

"I don't ask my husband for money anymore when children need new school uniforms or pairs of shoes, I handle such cases by myself", said Asia Abubakar with confidence. "I used to depend on my husband even for very minor cash requirements, but now that is history", she added. Similar stories were also told by a couple of other women at Bumbwini including Miza Makame and Maua Khamisi who admitted that since the SARD-SC project reached them, their lives have never remained the same. "We thank IITA/SARD-SC Project for empowering us. We are now more respected by our husbands because we assist in reducing their financial burdens, said Miza.

Zambia

SARD-SC in Zambia helps SAPP new project to spread cassava improved varieties beyond its zones of intervention

Since the inception of the SARD-SC Cassava project in Zambia, great strides have been made in transforming the lives of the target beneficiaries across the project catchment areas in Serenje, Mansa, Samfya, Kasama, and Kaoma districts of Zambia. The project currently promotes the growing of improved varieties and the variety extensively grown is the Mweru variety. It is a sweet variety with a maturation period of approximately 18 months compared to the local varieties that take an average of 24 to 36 months to mature. SARD-SC Cassava promotion has rejuvenated the cassava agenda in Zambia and has thus seen a significant forging of relationships that aim at improving the livelihood of rural farmers across and beyond the project catchment areas. One such relationship is the one that IITA-Zambia has forged with the Seed Certification and Control Institute (SCCI).

This partnership facilitated the establishment of Seed Multiplication fields across the project areas hosted by farmers following strict guidelines and standards, coupled with regular monitoring to ensure adherence. The fields that were established under the SARD–SC project have started to provide the much needed seed supply to other districts under a new project the "**Small-holder Agribusiness Promotion Programme (SAPP)", Cassava Intervention** covering an additional six

SARD-SC Host Seed Grower (SCCI Field) – Samfya District.

A New Field prepared in readiness for planting - Mbala district.

districts reaching a much greater population in the northern and northwestern part of the country. This partnership is important because of the dearth in knowledge that exists amongst farmers on the importance of growing high-yielding and disease-resistant varieties.

On the 3 December 2015 when IITA successfully launched the Smallholder Agribusiness Promotional Program (SAPP) that aims at improving linkages along the cassava value chain, the SARD-SC project had already made significant strides in setting up seed multipliers across the country and thus ensured that improved varieties were already grown on a large scale in the country. In Kasama District, we had a registered SCCI seed grower supplying cassava cuttings to Mbala and Chinsali districts where a partner project (SAPP) has activities being implemented. It is these significant synergies that the SARD-SC Cassava project continues to register within and outside project areas. The impact of the project has become significant in that other areas beyond the project scope are benefiting as well. A significant number of farmers in the northern part of Zambia have been captured under the multiplication exercise. It would be important to note that female farmers have been captured either as individuals or as groups who are now seed growers.

As at the end of January 2016, a total of 12 hectares of cassava multiplication fields were established in the Northern and Muchinga provinces of Zambia with direct linkage to the SARD–SC fields that where grown by SCCI and the Host Seed Farmers under the auspices of IITA.

Similarly, IITA under the SARD-SC project had set-up 1 hectare agronomy trials in Serenje District in the 2013/14 and 2014/15 seasons. The agronomy trials are being hosted on-farm by a smallholder farmer (Mr Minsula Chiboli). After the project collected data for analysis from the trial field that was established in the

2013/14 season, the cassava field was passed on to the host farmer and who has since been permitted to establish his own cassava fields and sell additional cuttings as well as the mature cassava roots to other interested farmers or organizations. The farmer has so far managed to sell to the SAPP project sufficient

Female led farmer group - Mungwi district.

M. Sinkana Godadi poses for a photo after establishing his 1 ha field.

cuttings to establish 4 hectares of cassava fields in Mpika District which is situated in Muchinga Province.

In addition he also sold 23 50-kg bags of dried cassava chips to traders from the neighboring Mkushi District in Central Province who in turn process the cassava chips into cassava meal which is sold as flour for preparing *nshima* which is traditionally a staple food in the northern regions of Zambia. In addition to receiving financial gains through the project, the farmer has also used the opportunity to host a cassava field day that was organized by the Serenje Innovation Platform where the Senior Chief Chibale of Serenje District was invited as the Guest of Honor and the Acting District Commissioner of Serenje was also in attendance.

Farmers peeling cassava roots.

Maize value chain

Accelerating maize transformational impact in Africa

Maize, the dominant cereal in Africa, has multiple uses as food in different forms and also to produce animal feed as well as being an industrial raw material for the production of a variety of processed goods. These multiple uses provide investment and employment opportunities along the maize value chain that can significantly contribute to the GDPs of a number of African countries. However, a major obstacle to improving rural maize farmers' productivity is land fragmentation which limits the ability of smallholder farmers to effectively embrace improved technologies and practices. In addition, the lack of structured markets, capable of linking smallholder farming communities to sustained output markets, leaves these farmers susceptible to the machinations of middlemen. These constraints have confined African rural maize farming communities to a vicious cycle of poverty, stemming from reduced productivity abetted by depleted soils, negative effects of climate change, and lack of an enabling environment to support an effective market driven, private sector led value chain.

For example, in Nigeria, more than 5 million ha are devoted to maize cultivation each year and account for 16% of the maize produced in Africa and 45% of that produced in the West African sub-region. About 98.8% of the maize production in Africa is rain-fed despite the huge untapped potential for irrigated maize production. Traditional farm practices passed down by successive generations of rural farmers dominate the African landscape. Less than 12% of rural farmers use mechanization; only 18% use improved seeds; 15% use herbicides, applying on average, about 6 kg/ha as opposed to 50 kg of fertilizer/ha as recommended by the African Union (AU). Post-harvest losses in maize are often higher than 20%. Annual growth rates for the area under maize cultivation grew by 4.2% between 1981 and 2012 compared with increases of 2.3% for

sorghum. 1.9% for millet and a little less than 5% for rice. Annual maize production grew by 5.6% compared with 3.9% for rice and 2.55% for sorghum. The area under maize cultivation in Nigeria increased from 438,000 ha in 1981 to 5,468,660 ha in 2015, resulting in an increase in production from 720,000 t in 1981 to 11, 947, 345 t in 2014. In 2015, maize production slipped back to 9, 463, 400 t, and was 6 million t short of the country's domestic requirements. Average yield increases in Nigeria have been minimal: 1.6 t/ha in 1981 to 2 t/ha in 2014, similar to average yields obtained in Ghana, Mali, and Zambia.

In view of these facts on the ground, the constraints faced by rural smallholder maize farmers and Africa's potential to change the narrative, the African Development Bank as part of its efforts to transform agriculture in Africa provided funds to IITA to implement the project Support to Agricultural Research for Development of Strategic Crops in Africa, SARD-SC in short. The program is designed to achieve three strategic objectives in low income Regional Member Countries (RMCs) of the Bank that have agreed to contribute to the effort:

- Increase agricultural productivity by 20% for four value chains identified by RMCs;
- Increase household food security and nutritional levels by 20%;
- Increase household incomes in the houses of targeted farmers by $300 per annum.

The project has four components:

1. Agricultural Technologies and Innovations Generation
2. Agricultural Technologies and Innovations Dissemination
3. Capacity Building
4. Project Management

Although appreciable real income growth at the farmer level remains elusive, production responses to affordable input supply, finance, and favorable prices have had a positive impact on maize production. Unfortunately, the pricing and procurement mechanics of major off-takers and the lack of available financial products structured for rural farmers has had a negative impact on the potential for growth in rural farming communities. Fortunately, however, maize as a crop has a number of characteristics that can assist its transformational impact in Africa. These include the following:

- High yield potential
- Diversified uses
- Ease of transportation, processing, and marketing
- Availability of dependable research products.

Two major constraints to be addressed in ensuring transformational impact are low yields on farmers' fields and availability and access to viable output markets. The yield gap can be addressed by the deployment of appropriate varieties in combination with good agronomic practices. Addressing the issue of fragmented markets through creating aggregation points and making use of multiple output channels will ensure viable market possibilities as yields increase. Other tangentially related but equally important requirements for transformational impact are an enabling environment which will effectively provide opportunities for private sector players along the value chain. Additionally, building the capacity of the partners and farmers targeted by the program will ensure the market linkages required for commercialization are reinforced. These two major elements were therefore the thrust of activities for the SARD-SC Maize in 2015.

Enhancing maize grain yield for transformational impact

Use of improved varieties

The SARD-SC Maize project leveraged earlier research outputs in each participating country but also engaged in the development of new products to ameliorate identified production constraints. Maize farmers are confronted with various biotic and abiotic stresses that have been partly responsible for their low productivity levels. The focus of the project was subsequently aligned to address the constraints faced by smallholder farmers as targeted elite varieties were introduced, well

suited to their production environment and emerging food–feed systems. During the year under review, seven sets of maize varieties comprising open pollinated varieties (OPVs) and hybrids with multiple resistance were evaluated in the three West African countries of the project. SARD-SC in Zambia was able to augment the work being done by the Zambia Agricultural Research Institute (ZARI) in developing and promoting multi-stress tolerant varieties. Indeed, as new varieties are developed, complementary agronomic conditions that enhance their performance are introduced.

Results from the trials showed that for the most part, the maize genotypes with multiple resistance were superior to their respective checks. As expected, yields were higher in the northern Guinea savanna (NGS) compared with the southern Guinea savanna (NGS) and forest zones of West Africa despite irregular rainfall conditions that prevailed during the season at many of the experimental sites. Mean grain yield within the intermediate/late maturity class was over 5 t/ha in Nigeria. Nineteen new genotypes that had superior grain yield above 35% over the checks across seven trial sets were identified in 2015 in Nigeria. In Ghana and Mali, six varieties were also selected that incidentally were part of the varieties identified in Nigeria. These will be further evaluated in 2016 for possible consideration for release to farmers and consumers.

Varieties identified in Nigeria are the following:

- Multiple Stress Tolerant Extra-Early Orange Hybrids: EEORH 12 and EEORH-16
- Early Yellow QPM Multiple Stress Tolerant Hybrids: EYQH-29 and EYQH-31
- Pro-vitamin A enriched 3-Way Cross Hybrids: LY1203-24, LY1203-26, and LY1203-43
- Aflatoxin Resistant 3-Way Cross Hybrids: AR1316-13, AR1316-17, and AR1316-22
- Yellow and White 3-Way Cross DTSTR Hybrids: 1401-3STR, 1401-4STR, and 1401-6STR
- Early Low-N Multiple Stress Tolerant Populations: LN-E-DMRSR -W SynC1, TZE31-DMRSR-LN Syn, and LN-E-DMRSR -Y SynC1
- Intermediate/Late Stem Borer Stress Tolerant Populations' Eld 4-W C1, BRTZL Comp 4 DMRSRC1, and BR LNTP-Y C6.

For example, the grain yield average obtained in the dry Katsina State of Nigeria ranged from 1.9 t/ha (Check 2) to 4 t/ha (LY 1203-24) among the late yellow hybrids. On average, four of the varieties had more than 20% yield advantage over the best check across all locations (Table 1).

Maize value chain

Table 1. Means for grain yield and related traits in Pro-vitamin A enriched 3-way cross hybrids across four States of Nigeria in 2015.

Genotype	Grain yield (kg/ha)					% Yield Adv best check
	Kaduna	Katsina	Kwara	Oyo	Across	
LY1001-6	4925	2087	5835	6762	4903	3.75
LY1001-7	6309	3328	5103	8732	5868	24.16
LY1001-26	5271	3248	5545	9025	5772	22.13
LY1203-20	4712	2622	5271	6922	4892	3.51
LY1203-24	4259	4020	6331	8892	5875	24.31
LY1203-43	6043	3514	5407	9105	6017	27.32
Check-2	4978	1943	2995	7241	4289	
Check-1	4978	2449	3464	8013	4726	
Planting site (PS)	**	**	**	**	**	
Genotype (G)	**	**	**	**	**	
G × PS	**	**	**	**	**	

Table 2. Grain yield (kg/ha) at 90 kg N of multiple stress tolerant maize populations evaluated across three locations in the Guinea savanna zone of Ghana during the 2015 season.

Entry name	Locations			Across	Rank
	D.C Kura	Gunsi	Puriya		
LN-E DMRSR-W-Syn C1	5005	5439	4097	4847	3
TZE31-DMRSR-LN Syn	4971	4932	4548	4817	5
LN-E DMRSR-Y-SynC1	5556	4728	4205	4830	4
OMANKWA	5656	5265	4273	5064	1
EARLY LN-W	5242	5323	4120	4895	2
TZE3-DTC2-LN SYN	5244	5124	4037	4802	6
ABONTEM	5442	4693	3839	4658	7
EW-LN-POP	4543	5356	3910	4603	8
MEAN	5207	5107	4129	4815	
SED	290.4	255.1	282.8		
CV%	15.9	17.2	14.6		

Similarly, grain yields of over 4 t/ha (Table 2) were obtained across three sites in Ghana in 2015 to diversify the early maturing varieties being introduced for cultivation during the second season in the predominantly maize growing areas of the transition zone in the middle of the country.

For Zambia, three varieties, stress tolerant- CZH1257, CZH1263, and CZH1272 from the National Performance Variety Trials (NPVT) of 2014/2015 sponsored by the project- were identified and are slated for release later in the year.

Table 3. Stress tolerant- CZH1257, CZH1263, and CZH1272 NPVT- 2014/2015 in Zambia.

Entry	Variety	Rel GY	Averaged		Av.Gy	Lusitu	Masumba	GV	Msekera	SCCI	Mutanda	Misamfu	Pmaturity	AD	PH	Turc	GLS	MSV
			Rank	Stdev	t/ha	t/ha	t/ha	t/ha	t/ha	t/ha	t/ha	t/ha	days	days	cm	1_5	1_5	1_5
4	MRI 514©	83.9	11.4	5.5	4.33	0.68	2.88	8.24	6.68	5.77	2.21	3.83	123.8	60.3	235.5	1.7	1.3	2.2
7	PAN 413©	94.1	10.3	5.6	4.85	0.24	2.58	9.43	6.60	6.18	3.40	5.54	125.4	59.5	213.9	1.7	1.5	1.4
12	CZH 1272	90.7	11.7	2.9	4.68	2.84	2.45	7.35	5.27	6.38	4.38	4.08	124.7	54.5	231.0	1.5	1.6	1.3
13	CZH 1257	96.4	10.3	5.0	4.97	3.58	2.45	7.34	5.95	4.14	3.85	7.49	119.0	50.4	237.3	1.7	1.7	1.6
14	CZH 1263	99.9	9.3	7.4	5.15	5.20	3.70	6.89	5.96	10.06	1.45	2.82	124.5	56.0	228.2	1.4	1.4	1.6
15	HP 1304	95.1	11.0	5.9	4.91	5.05	2.53	6.85	5.67	6.46	6.09	1.70	116.0	53.5	216.4	1.3	1.3	1.7
17	PHB 3253©	109.9	8.3	6.0	5.67	4.98	2.21	7.34	7.89	8.19	3.21	5.87	126.3	59.2	238.1	1.5	1.7	1.5
18	DKC 8033©	82.5	13.3	3.0	4.26	1.57	2.37	5.40	6.17	7.17	3.79	3.35	122.4	56.7	231.7	1.2	1.3	2.7
Mean			9.5	5.1	5.16	3.12	2.70	7.37	6.29	7.19	4.41	5.03	123.8	57.4	231.3	1.57	1.52	1.63
Min			5.1	2.9	4.26	0.24	2.15	4.94	3.80	4.14	1.45	1.70	116.0	50.4	211.2	1.21	1.25	0.96
Max			13.3	7.4	6.30	6.20	3.70	9.43	8.42	10.44	7.41	8.76	130.1	61.5	247.6	2.46	2.16	2.74

Improved agronomic practice

The use of the appropriate planting density is perhaps after fertilizer application the factor most limiting yield in maize production. Density affects plant architecture, alters growth and developmental patterns, and influences carbohydrate production and partition. Maize is more sensitive to variations in plant density than other members of the grass family. Optimum plant density ensures plants grow properly, both in their aerial and underground parts, through different uses of solar radiation and nutrients. Higher than optimum density causes severe competition among plants for light above ground or for nutrients below ground, consequently plant growth slows down and grain yield decreases. Among different essential nutrients, the nitrogen deficiencies found in most soils have a profound effect on plant growth and development owing to the crops' metabolic and physiological needs. The beneficial effects of nitrogen on the yield potential of maize can be realized only when adequate fertilization and optimum plant population are adopted. Consequently, the project embarked on disseminating results from on-farm trials earlier conducted on double crop density and increasing fertilizer dosages. Essential to the development of this technology is the use of post-emergent herbicide for weed control because manual weeding in dense population is practically impossible.

A doublt density/ double fertilizer demonstration trial in Ghana.

Agronomy Workshop

To properly understand and use the appropriate density, agronomy workshops were organized by SARD-SC Maize in Abuja Nigeria, and Tamale Ghana, early in the year to equip project staff and associates with the technical capacity to design and undertake scalable agronomy trials and demonstrations. Topics considered included plant architecture and optimum spacing arrangement as well as fertilizer dosages and weed management options in varying density scenarios. The training enabled Country Coordinators and their collaborators to undertake and practive this complementary option for crop management especially in Zambia due to seasonal variations in rainfall. A consequence of the introduction of double density planting is the recent registration of Nitrosulforon, a

post-emergent herbicide for weed control in maize promoted in Ghana, Nigeria, and Mali. Thereafter, different plant density arrangements were developed and modified for demonstrations.

In Ghana, various modifications were made of the original double density pattern that involved splitting the 75 cm row into 40 cm and 35 cm to double the otherwise 53,333 plants/ha from the traditional 75 cm between rows and 25 cm between hills within the row. These included:

- DDM2R - Double density maize, that is doubling the rows to obtain 40 cm and 35 cm and planting one seed per hill but in a triangular display
- DD2M1R - Double density maize using one row, two plants per stand in the traditional 75 cm by 25 cm
- NDM1R - Normal density maize of one row with one plant per stand using the traditional 75 cm by 25 cm

Three levels of nitrogen application were also considered:

1. Recommended rate, that is, 100N:50P:50K
2. Double recommended rate to become 200N:100P;100K
3. One plus a half of the recommended rate that is, 150N:75P:75K .

Results obtained (Tables 4 and 5) revealed that splitting the row into two to double the plant

Table 4. Grain yield (kg/ha) of maize as affected by different density and fertilizer levels at Kintampo North and Nkoranza South districts of Ghana.

	Kintampo			Nkoranza		
Treatments	*Abontem*	*Omankwa*	*Local*	*Abontem*	*Omankwa*	*Local*
DDM2R + 100 kgN/ha	2364	2409	2422	3617	3337	2568
DDM2R + 50 kgN/ha	3213	2907	2542	4160	3528	2688
DDM2R + 200 kgN/ha	**4738**	3489	2698	**6084**	4835	2844
DD2M1R + 100 kgN/ha	2924	2609	1987	3888	3455	2400
DD2M1R + 150 kgN/ha	3204	2884	1813	4051	3682	2631
DD2M1R + 200 kgN/ha	3511	2982	2347	4857	4328	2955
NDM1R+100 kgN/ha	1742	1702	1633	2951	2848	1853
NDM1R+150 kgN/ha	2067	2404	1687	3008	2951	1980
NDM1R+200 kgN/ha	2840	2664	1882	3786	3111	2746
CV	23.5			27.3		
SED	738.5			876.4		
Mean	2580			3376		

Table 5. Grain yield (kg/ha) of maize as affected by different density and fertilizer levels at Mampong and Sekyere Central in the forest region of Ghana.

	Mampong			*Sekyere Central*		
Treatment	Abontem	Omankwa	Local	Abontem	Omankwa	Local
DDM2R + 100 kgN/ha	2938	2204	2791	3094	3414	2245
DDM2R + 150 kgN/ha	3053	3078	2796	3648	3016	2308
DDM2R + 200 kgN/ha	3321	**4916**	3258	**4964**	**3805**	**2429**
DD2M1R + 100 kgN/ha	2938	2884	2045	3531	3398	2243
DD2M1R + 0 kgN/ha	3302	2924	2046	4028	3708	2108
DD2M1R + 00 kgN/ha	3382	3338	2061	4334	3715	2032
NDM1R + 100 kgN/ha	2933	2440	2065	2428	2680	2330
NDM1R + 150 kgN/ha	2440	3547	2751	2485	2768	2357
NDM1R+200 kgN/ha	3347	3609	2516	3263	2935	2865
CV	10.6			16.4		
SED	888.1			612		
Mean	3055			3190		

Double density/1.5 fertilizer in Katete, Zambia.

population and doubling the recommended fertilizer rate resulted in doubling the yields of Abontem in Kitampo and Nkoranza districts of Ghana without any major change in plant architecture (Table 4). Similarly, the yield of Omankwa was doubled in Mampong, resulting in the resolution taken by farmers to plant maize only in the double density arrangement.

Results obtained from demonstrating the efficacy of double density and increased fertilizer applications in Zambia were even more impressive. Results from the more than 50 trials conducted convinced farmers that double density technology was financially feasible and economically rewarding. A yield of about 8 t/ha (Table 6) was obtained from doubling the plant density and increasing fertilizer application by only 50% in several farmers' fields across Mkushi and Katete districts of Zambia.

Table 6. Effect of adjusting fertilizer and density rates in Zambia.

Treatment	Kg/ha
RD + RF 1 plant/stand	6100
DD + 1.5F 1 plant/stand	7900
DD + DF 2 plants/stand	7400
DD + RF 1 plant/stand	5800

RD = Regular density, DD = double density, RF = Regular fertilizer, DF = double fertilizer.

Table 7. Preliminary results based on researcher managed on-station trial – Year 1-2015/2016 season.

Treatment	Grain yield kg/ha	Plant/population ha
1. Research recommendation – 75 cm × 25 cm ×1 seed/station (A)	4648	49,833
2. Farmer's practice – 90 cm × 30 cm × 1 seed/station (B)	3933	33,500
3. Modified recommendation #1–75 cm × 20 cm × 1 seed/station (C)	7253	66,500
4. Modified recommendation #2–40 cm × 35 cm × 1 seed/station (D)	8000	113,833
Grand Mean	5959	65,917
CV%	19.7	17
LSD (0.05)	3260	31,130
F Pr	0.064	0.008

Table 8. Economic analyses of using different densities and fertilizer rates for maize production in Zambia.

	Yield kg/ha	Gross Income @ K 1.7/kg	Fertilizer (400kg) K 380/bag	Seed K 20/kg	Labor (50 man days@ K25/day)	Herbicide 700/ha	Total Variable Cost (K)	Net Income (K)	ROI
A	4648	7901.6	3040	300	1250	700	5290	2611.6	0.49
B	3933	6686.1	3040	300	1250	700	5290	1396.1	0.26
C	7253	12,330.1	3800	375	1250	700	6125	6205.1	1.01
D	8000	13,600	6080	600	1250	700	8630	4970	0.58
Grand Mean	**5959**	10,130.3	3990	393.75	1250	700	6333.75	3795.7	0.5866

Table 9. Performance of maize varieties under different population densities and fertilizer rates across three sites in Nigeria (2015).

	Treatment combination		
Variety	Plant density	Fertilizer rate (NPK)	Average grain yield (t/ha)
	Kaduna State planting site		
BR9928DMRSR-YC2	1 row, 2 plants/stand	100:50:50	5.85
PVA8	2 rows, 1 plant/stand	150:75:75	5.78
LNTP-YC_2	1 row, 2 plants/stand	100:50:50	5.56
LNTP-YC_2	1 row, 1 plant/stand	200:100:100	5.42
LNTP-YC_2	1 row, 1 plant/stand	100:50:50	5.33
	Nasarawa State planting site		
LNTP-YC_2	1 row, 1 plant/stand	150:75:75	6.49
PVA8	1 row, 1 plant/stand	150:75:75	6.25
BR9928DMRSR-YC_2	1 row, 2 plants/stand	150:75:75	5.98
BR9928DMRSR-YC_2	1 row, 1 plant/stand	150:75:75	5.90
PVA8	1 row, 2 plants/stand	100:50:50	5.83
	Oyo State planting site		
PVA8	1 row, 1 plant/stand	150:75:75	6.50
BR9928DMRSR-YC_2	2 rows, 1 plant/stand	150:75:75	6.33
BR9928DMRSR-YC_2	2 rows, 1 plant/stand	150:75:75	6.17
BR9928DMRSR-YC_2	1 row, 2 plants/stand	200:100:100	5.50
BR9928DMRSR-YC_2	1 row, 2 plants/stand	100:50:50	5.33
SED			0.749

A detailed study of the variation in density and fertilizer rate conducted on-station (Table 7) revealed that an optimum plant density of about 114,000 plants/ha is achievable to obtain a yield of 8 t/ha compared with the farmers' practice that gave only 3.9 t/ha. A slight modification of the planting arrangement but one that doubled the stands from the farmers' practice also gave a yield of 7.3 t/ha. Economic analyses of engaging in the modified enterprise (Table 8) shows that using either of the modifications that directly double farmers' practice or more than double farmers' practice will give a net benefit of almost 5000K and 6200K, respectively.

Double density / 1.5 fertilizer rate in Mkushi district, Zambia.

Testimony

Mr Emmanuel Bakut is a farmer, 52 years old, married with several children. He has over 35 years of farming experience in planting maize in the same way he had inherited from his father until his encounter with SARD-SC Maize Project. In 2015 cropping season, he volunteered to participate in the joint establishment of one of the trials on double density and to teach other farmers in his locality of Fadan Kaje in Samaru Kataf. That decision entrusted him with the leadership of his fellow farmers working with SARD-SC Project. According to him, he laughed at what was being done at the time. He began to take a serious look at the trials when he saw good cobs forming in the plots he had once likened to a ginger farm in their early stages. Some of the plots produced almost 8 t/ha. He produced 22 bags (about 90 kg each) of maize from the trial farm of about 0.25 ha. Upon seeing the miracle, he was convinced. He promised to put all his maize farms under double density and to teach his fellow farmers. He used double density in his second maize crop on another plot in the same year to produce 37 bags.

Table 10. Fertilisation organo-minérale à base de l'engrais organique Profeba de fabrication nationale.

PLATEFORME	COMMUNES	VILLAGES	PAYSANS	avec Profeba	sans Profeba
Sanankoroba	Dialakoroba	Dialakoroba	Adama Togo Samaké	2888	2688
		Dialakoroba	Bassidi Samaké	3648	3248
	Narena	Narena	Issa Negué Koné	6146	5460
	Sanankoroba	Sinsina	Hamidou Doumbia	6000	4000
		Sanankoroba	Abdoulaye S Traore	3280	2160
		Tadianabougou	Souleymane Konate	2800	2000
Kita	Kita-Nord	Sibikili	Boubacar Sow	1180	850
	Kassaro	Manaboucou-coura	Karamoko Diakité	2000	1600
Moyenne				3492,75	2744,5
ppds à 0.05 seuil d'alpha = 487.211			CV (%)	13,21%	

Thus, after just one year of participating in the evaluation of double density planting and application of 50% more fertilizer he showed a strong disposition to adopting the technology. He eagerly tells his guests of the magic and his desire to continue the practice in all his maize farms and says he has shown the technology to over 30 other farmers who are seemingly in a hurry to try it next season.

Other complementary crop management options promoted

In addition to demonstrating and encouraging the use of double density, the project also vigorously promoted the use of organic fertilizers (Table 10) in the Sahelian zone of Mali. The positive outcomes convinced the Government to include organo-fertilizer as an input in the Government- sponsored subsidy scheme. Although very striking differences in a few cases were not obtained from using organic fertilizers, their use will improve the soils' physical structure while enhancing yields. The project continued to partner with the Government of Mali on >2000 ha maize production continuum in Sanankoroba for profitable maize cultivation.

Nitrogen efficient maize in soybean–maize rotation: a sustainable productivity enhancement system

In the savanna zones continuous cropping has been entrenched because of an increased scarcity of land. Furthermore, soils are poor, being very low in nitrogen and organic matter due to overgrazing, use of crop residue for animal feed and outright burning of residue to allow a fresh flush of grass with the onset of rains. However the ecology is the most suitable for maize production due its abundant sunshine, availability of adequate moisture during the required five to six months duration of the growing period.

The farmers' decision to cultivate the crop is often determined by

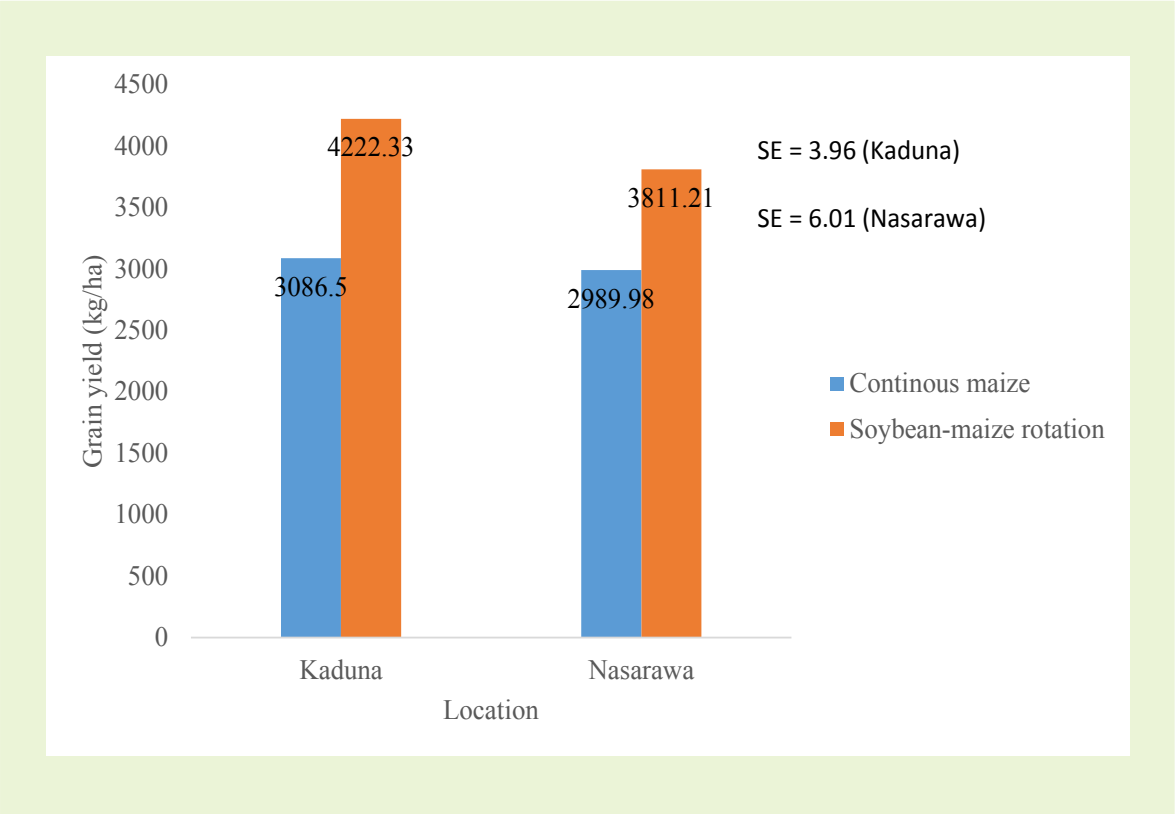


Fig. 3: Effect of crop rotation on maize yield in both locations 2015 wet season.

the availability of fertilizer and an assurance of a fair price for maize grain that can offset investment on fertilizer use. Thus any technology which reduces fertilizer input in maize production is attractive to famers for the two prime reasons. Farmers prefer to grow maize because it is consumed in multiple forms and its yield is commonly higher than those of other cereals.

SARD-SC Maize project introduced soil health improvement technologies that not only boosted the productivity of maize but also diversified the income base of farmers. Soybean is a cash crop to many famers throughout the moist and humid savannas. The soil nutrient enhancement attribute of soybean is being exploited by incorporating its production into maize farming. Although the integration of soybean in maize fields is not new, combining soybean with varieties which are efficient in the use of soil nutrients, especially nitrogen, offers farmers the option to save on nitrogen fertilizer investment.

IITA recently developed Low Nitrogen Tolerant Population (LNTP) maize varieties that out-yield farmers' varieties at N-fertilizer levels of 3060 kg. Under the SARD-SC Project, these varieties were further improved and made available to various countries for release to farmers. The LNTP varieties when used in combination with soybean in rotation or as an intercrop enable farmers to gradually build up the native nutrient level of their soils without significantly compromising their grain yields.

Figure 3, for example, shows an increase of more than 30% in the grain yield of maize planted in rotation with soybean in Nigeria. This maize variety is also tolerant to several other stresses such as the dry spells and drought that worry farmers throughout the maize belt of the savannas. The project is using the concept of the seed drop to facilitate access to the seeds of such identified varieties to promote their commercialization by partner seed companies on the IPs established in all the countries.

Accelerating technology diffusion

To create awareness and adoption of improved seeds and other maize technologies, more than 5 t of seeds were distributed in mini-packs as seed drops using elite varieties whose superiority in terms of grain yield and adaptability to local stress had been confirmed. Some of the varieties incorporated in this technique of diffusion include IWDC2, LNTP-Y C2, LNTP W, 2000SYNEEWSTR, and BR9928DMRSRY. Table 11 shows that the improved varieties distributed in mini-seed packs to farmers out-yielded farmer's checks by over 88%. The project has organized more than 50 field days during which over 60000 participants attended across sites.

From more than 5000 demonstrations now conducted with seed drops of newly released and improved varieties and other agronomic trials it is clearly demonstrated that a yield of 4.2 t/ha is obtainable and can get to 8 t/ha with double density and increased fertilizer application.

The question therefore is why yield are still so low. Yields are still low because of low input use and poor price incentives for produce.

Table 11. Grain yield of improved stress tolerant maize and farmers' variety in Saki West and East LGAs of Oyo State in Mini-kit trials (2015).

Entry	Plant population (no.)	Plant height (cm)	Cobs/ha (no.)	Maize yield (t/ha)	Grain yield advantage over the Check (%)
Farmer's Variety	16,520	192.0	14,760	2.00	
LNTP-W	43,280	153.3	39,780	5.04	152
Sed	1026.30	6.77	1322.40	0.28	
Farmer's Variety	25,857	175.70	22,286	2.65	
BR9928DMRY	42,686	155.40	39,571	4.99	88.3
Sed	1517.40	5.43	1316.80	0.32	

Maize value chain

Low input use is a result of farmers' inability to buy the recommended inputs due to non-availability of money as and when needed for that purpose. Since this is known it can be addressed by linking farmers directly to the input-output markets in such a way that targeted users end up pulling the production and supply end. Consequently, the project encouraged the institutionalization of input-production-market linkages through the formation of commodity associations where all major actors in the value chain can come together with a common understanding of needs, services, and products. This thus needs the formation and use of megsized Innovation Platforms that link industries to production in a structured approach manner.

The IPs introduced by SARD-SC in each of the four maize growing countries and soon to be introduced in Cameroon and the DRC were designed to address some of these constraints. These IPs provide opportunities for stakeholders such as the Maize Associations in Nigeria, Mali, and Ghana to link up with farmer-based organizations (FBOs) that have adopted farming as a business with the accompanying increases in the quantity and quality of grain supplied to the market. In addition SARD-SC has actively engaged input supply companies in the production of foundation seeds and certified seeds sometimes produced in conjunction with community seed multipliers trained and supported by the program. These input companies have also been linked to FBOs seeking to purchase improved varieties of seeds and chemical inputs in a demand-driven fashion where farmers are encouraged to seek those products that are fit for purpose.

Innovation Platform Operations

Although the use of supportive pillars such as technology demonstration and promotion for maize value chain performance improvement for smooth operations was undertaken in 2015, the project focused its attention more on activities that can enhance the quick adoption of improved technologies for the improvement of crop productivity and the standard of living of resource-limited farmers in the target zones and countries. It also promoted various platforms aimed at strengthening maize consumer market-Farmers-Input linkages and facilitated various monitoring efforts seeking to align activities to expected project objectives.

While the established IPs focused on building the capacity of actors in the maize value chain to conduct their businesses independent of Government patronage and advisory support, critical constraints identified by targeted farmers were addressed on a needs basis. For example in Nigeria, the Maize Association of Nigeria (MAAN) pointed out finance was a limiting constraint faced by farmers. This necessitated SARD-SC Maize, working with the First City Monument Bank

A cob from one of the double density fields in Zambia.

Mali Maize ASSOCIATION

Président : El Hadj Moussa Traoré (Transformateur) Sikasso 760653 91/97 32 26 57
Vice-Président : Salif DOUMBIA : (Transformateur) Bamako 66 71 59 57/73 99 67 04

Membres :

1. Siratigui N'Golo Diarra (producteur): Koulikoro 73 08 49 43 /
2. Sidy Sissoko (producteur): Kayes 79 26 79 77/72 37 39 81
3. Belco Tamboura (producteur) : Ségou 63 31 85 42/76 16 29 14
4. Bakary Mallé (producteur): Sikasso 76 05 33 49/65 46 12 80
5. Mme Thiéro Djénéba CISSE (Transformatrice) Ségou : 66 84 94 00/75 61 56 86
6. Monsieur Dramane THIERO (Commerçant) Ségou : 66 77 29 91/76 38 36 29
7. Monsieur Adama DISSA (Commerçant) : Sikasso : 66 79 97 89/78 15 06 03
8. Monsieur Toukouna KONARE (Commerçant):(Kita-Kayes)66 92 72 77/ 75 82 27 98

(FCMB), to develop a financial product that is expected to meet the needs of the various MAAN chapters. An aggregator borrower scheme was developed in which aggregators working with targeted farmers were identified to act as obligors on behalf of their cluster of farmers. Farmers deposited up to 20% of input costs in their local FCMB branches, this is topped up by additional financial contributions from the respective aggregators whose collateral is considered to mitigate risk exposure by the Bank. Four aggregators were successful in securing a Facility 1 loan for input purchase and some are considering a Facility 2 loan offered by the Bank for trade finance during harvest. Furthermore, Heritage Seeds in Ghana and Faso Kaba Seeds in Mali working with the project team engaged farmers in the production of certified seeds to supply an assemblage of small-scale farmers for grain aggregation. Farmers are being encouraged to use known varieties for bulk supply to Grain Leaders in Ghana and the newly formed Mali Maize Association.

In an effort to source niche markets for targeted farmers discussions were started with a processor looking for access to specific varieties currently in the IITA stock or pipeline for cornflakes production that could be released to meet the needs of the company. Using its comparative advantage, the project evaluated several maize genotypes for desirable end-user characteristics to showcase the availability of materials with qualities desired by industries and other target groups. Table 12 is a profile of 174 varieties in IITA stock available for interested industrial processors of maize.

Table 12. Physicochemical characteristics of 174 maize varieties for end-user linkages.

Parameters (%)	Mean	Min	Max	Std error
Moisture content	10.57	9.19	12.00	0.04
Ash	1.29	0.98	2.00	0.01
Fat	4.58	3.36	6.61	0.03
Protein	8.78	4.87	11.91	0.06
Sugar	2.77	0.80	5.90	0.06
Starch	60.78	43.00	86.00	0.43
Digestible CHO	64.14	45.71	89.89	0.44
Amylose	23.76	19.93	35.69	0.12
Amylopectin	76.24	64.31	80.07	0.12

Strategic platforms

During the year, several strategic platform teams were set up. The team in Nigeria consisted of MAAN, Seed Entrepreneurs Association Development Association of Nigeria (SEEDAN), Nigeria Commodity Exchange (NCX), and Strategic Grains Reserve (SGR) and focused on addressing market linkages. No fewer than 24 partnerships

Open maize storage in Mali.

Meeting with NCX, Flour Mills of Nigeria PLC, IITA and MAAN.

Maize value chain

fostering engagements were facilitated. This resulted in demand indents in excess of 35,000 t from five companies. It became obvious that such teams are needed in other countries to, create an avenue for stakeholders within the maize value chain to come together to satisfy a common desire for quality maize grain production for targeted markets among other possibilities. Consequently, SARD-SC Maize facilitated the formation of Mali Maize Association with direct linkages to the Common Market of the francophone countries in the sub-regionl to the Government's subsidy program, as well as end-users. More than 2000 ha of land were then earmarked for maize production by this group in 2016. A working committee was formed to oversee the affairs of the new commodity association in Mali.

Similarly, the Ghana National Stakeholder Association was formed but is yet to hit the ground running, unlike that of Mali.

To smooth the process of executing the orders, links to financial institutions were initiated which were at various stage of development at the close of the season. Despite the progress made, an enduring mechanism for the determination of maize grain price and for enhancing price discovery among farmers remained a challenge.

Building trust and collegiality

A major obstacle to maize marketing is the lack of trust between end-users and farmers. Farmers often believe that end-users are there to cheat them while end-users also assume that farmers will not provide the quantities and qualities agreed upon in a timely manner. More importantly, end-users are often weary of side-selling if the prevailing market price at the time of harvest happens to be more competative than the contractually,negotiated price. Furthermore, it is often believed that producers will always renege on contracts, especially when they have received an indent to produce, viewing such deposits as their share of any national cake. However the essence of any successful value chain implementation arrangement is based on the following:

- Shared goals among partners
- Trustworthiness, transparency, openness, and honesty
- Professionalism
- Willingness and ability to work in partnerships
- Tolerance and respect for others
- Commitment, dedication, consistency, enthusiasm, and reliability
- Accountability - upwards and downwards
- A value chain is equitable and empowering.

And also innovative, creative, and adaptable.

There is therefore the need to have a mediator, usually serving as honest broker, between the producers and end-users. However such brokers need the financial muscle to pay for produce when delivered and after inspection and also deliver the produce to the end-users when needed. SARD-SC Maize working in partnership with commodity associations is thus poised to serve as this honest broker to ensure that farmers get paid on delivery of quality maize grain and ensure that such quality grain gets to end-users through binding contracts. Negotiations and delivery of quality inputs, seeds, and fertilizers, can also be achieved under the direct influence of SARD-SC Maize and used to pay farmers in-kind for grain delivered.

To achieve these market linkages, SARD-SC Maize has engaged MAAN, the commodity association representing the interests of the crop in Nigeria, the Seed Enterprise Association in Nigeria (SEEDAN), and a number of other

end-users including the Grand Cereal Ltd in Jos, the Livestock Feed Co. in Lagos and the Flour Mills of Nigeria PLC in Lagos on issues related to maize commodity bulk marketing with the Nigeria Commodity Exchange (NCX) playing a pivotal role in ensuring compliance by all concerned, if and when contracts are signed.

A similar function is being played by the project in partnership with the recently formed Mali Maize Association.

However, a major challenge to the success of this effort is the issue of uncompetative interest rates being offered by financial institutions to support the effort. Banks are reluctant to give agricultural credit because of the the perceived risks inherent in rural agricultural lending and the lack of collateral. Using a modification of the SSA-KKM project under FARA in the IP of Sahel in Maradi, the project in Nigeria engaged the FCMB in discussions aimed at ensuring an equity contribution by interested partners, in this case, farmers through their commodity association, aggregators to bulk grains and the Bank itself, to reduce risk exposure on loans. Through this arrangement, farmers' groups could source fertilizers and improved seeds from quality suppliers through the aggregators, This ensures they get quality inputs on time. This system ensures aggregation of grain for delivery to bulk end-users. In Mali, Kafo Jiginew is equally linked to ensure such access to credit.

Summary

SARD-SC Maize believes that creating aggregation schemes will lead to increased demand for improved seeds and fertilizers and indeed other agrochemicals, the major elements for on-farm yield increase. It will equally create opportunities for better price bargaining. Furthermore, SARD-SC Maize knowing that:

- **Enhanced competitiveness is a function of market and yield and summarizing same as below**
  - Market = *f*(Yield + Price)
  - Yield = Quality input use + Agronomy
- **Recognizing that Commodity Association is the**
  - Voice of the voiceless
  - Aggregation of value chain actors
  - Linkages of/and common understanding
- **Clustering of smallholders will ensure**
  - Bulk linkage to input–output markets
  - Taking production technologies to scale
  - Aggregation for bulk delivery
  - Linkage to finance.

The SARD-SC Maize project is therefore poised and is building trust and collegiality, intangible but invaluable elements for enhancing maize competitiveness, among value chain actors for transformational impact in target countries.

Bags of maize in the maize cold store.

Rice value chain

Technologies and innovations generated

1. Testing of mechanical weeders in Nigeria and Benin

Forty ring hoe weeders were fabricated and distributed to farmers for assessment in their rice fields in the Benue/Nasarawa innovation platforms (IPs) in Nigeria. The ring hoe weeder was light in weight, easy to operate by farmers, especially women, and is more effective compared to the small hoes that the farmers used. According to farmers, the ring hoe weeder is time saving, easy to use, and lessens drudgery (reduces backache). In addition, the weeder is multipurpose as it could be used in maize, groundnut, and cowpea fields.

Sixty weeders (ring hoe) were fabricated and given to 60 farmers (37 women and 23 men) in the Glazoué innovation platform in Benin. So far, 58 farmers who are directly working with the SARD-SC project have used the ring hoe, and another 264 non-recipient beneficiary farmers have also tested it.



Figure 1. Farmers in the Glazoué IP (Benin) using the ring hoe weeder.

2. Testing of motorized weeders in Tanzania

Three types of motorized lowland rice weeders were tested (Fig. 2) against a hand-pushed rotary weeder in Tanzania. The tests involved 237 rice farmers and other stakeholders, including researchers, agricultural extension officers, community development officers, local blacksmiths, representatives of the local governments, and NGOs.

Preliminary results show that farmers are highly interested in the motorized weeder and expressed the need to improve them. The average farm size of the farmers interviewed was 2.6 acres (about 1 ha). According to the interviewees, each farmer spent an average of 85,000 TZ Shillings (equivalent to US$40) on weeding. The four weeders tested were scored by farmers based on three criteria: (1) ease of operation, (2) effectiveness in terms of weed control, and (3) time required for weeding.

The double-row Indian-type weeder and the double-row Japanese-type weeder were the most preferred for both the first and second weeding operations. The Indian-type double-row weeder is preferred for its effective weed control and the Japanese type for its ease of operation, stability, and light weight. Farmers were willing to pay 458,000 TZ Shillings (US$214) for a motorized weeder of their choice or 43,000 TZ Shilling (US$20) per acre for weeding by a service provider.

Based on the feedback from farmers, a local prototype will be developed and tested with them in a participatory manner. The prototype will most likely be a hybrid between the Indian and Japanese double-row weeders-combining the rotator-type of the Indian design (for effective weed control) with the two-floaters of the Japanese design (for stability and ease of operation).

Figure 2. Motorized weeders being tested in Tanzania.

3. Testing of RiceAdvice in farmers' field in the Senegal River Valley

A total of 136 farmers with total area of 93 ha received recommendations provided by RiceAdvice through AfricaRice's partner SAED (extension) in the 2015 dry season in the Senegal River Valley. On average, yield increase was 1.2 t/ha. Among 112 farmers, 76% of farmers got higher yield using the recommendations. After harvesting their rice in the 2015 dry season, when farmers were asked if they wanted to use RiceAdvice for the next season, 125 out of 136 answered "yes" (92%). These results indicate that RiceAdvice offers a new approach to increasing the yield of irrigated lowland rice in farmers' fields in Senegal. In the 2015 wet season, RiceAdvice was disseminated to > 400 farmers through SAED and the youths supported by SARD-SC (Fig. 3), and 360 farmers in Kano in Nigeria.

Figure 3. A female youth interacting with a female farmer on her preference for RiceAdvice recommendation in Senegal River Valley.

4. Testing of Good Agricultural Practices (GAPs) in Tanzania and Uganda

Good Agricultural Practices (GAP) including the use of improved varieties, fertilizer management, improved water management, timely weeding, and proper use of herbicides have been tested. Data from Tanzania and Madagascar show that the GAPs have doubled rice yields to 1.8–4.8 t/ha compared to 0.8–2.4 t/ha using farmers' practices in rainfed lowland conditions. Under upland rice conditions, GAP plots yielded 1.9–5.1 t/ha compared to 1.5–2.7 t/ha with farmers' practices.

In Chela village (Kahama hub in Tanzania), a farmer named Makondo Magesse (Fig. 4) reported during a field visit that: "Where I used to harvest 900 kg of paddy under traditional practices, I now get 2250 kg with the use of GAP, and under GAP, I use less space but harvest more paddy. In addition, planting in rows makes weeding easier and reduces the seed rate (10 kg/acre compared to 50 kg/acre with broadcasting)."

Figure 4. Mr. Makondo Magesse (standing) with his children in his field, giving his testimony.

In Mazimasa village, Butaleja District within the Doho hub of Uganda, the use of good agricultural practices has brought about yield increase for farmers, as testified by some of them: "My name is Kiore Swaibu. I work as an Internal Security Officer (ISO) and I am not a member of the Mazimasa group but, because I am close to the Mazimasa swamp, I also developed an interest in the technologies availed by NARO under the SARD-SC project. I have been getting 120 kg of milled rice from a quarter (¼) of the field with the improved Kaiso rice variety. However, when I used WITA 9 and applied good agricultural practices, I managed to get 420 kg of milled rice. I am happy with the technologies and will continue to use them."

5. Testing of rice husk gasifier stove technologies

The rice husk gasifier stove (Fig. 5) that relies on solar energy to power a fan has been constructed for use in rice parboiling. This stove can use rice husks or husk pellets. When husk pellets are used, the burning time increases 5-fold. Also, one motorized briquetter/pelletter and a motorized mixer (Fig. 6) have been constructed and are being tested. The motorized briquetter can produce both briquettes and pellets (Fig. 7).

Figure 5: Rice husk gasifier stove relies on solar energ

Figure 6: Motorized mixer and briquetter

Figure 7. Briquettes and pellets made with the motorized briquetter.

Dissemination of technologies and innovations

1. Dissemination of improved rice varieties in partnership with private seed enterprises in Mali and Uganda.

In Mali, certified seed has been produced through partnership with seed enterprises FASO-KABA. About 3.6 tons of foundation seed (13 rice varieties) was produced by SARD-SC in partnership with FASO KABA seed enterprise and 2.7 tons of this was delivered to FASO-KABA for certified seed production. FASO KABA in turn produced 150 tons of certified rice seed of nine varieties from the foundation seed it received from SARD-SC.

In Uganda, foundation seed of improved varieties (Namche1, Namche3, and Namche6) was produced through NARO in partnership with seed enterprises. A total of 11.5 tons of foundation seed was produced in partnership with NASECO (6.5 tons) and ADAG-ANII (5 tons), respectively.

Figure 8. Faso Kaba outgrowers farm at Zantiedougou.

2. *Striga* Management ~~a~~ farmer-to-farmer instruction video for upland rice

AfricaRice/SARD-SC and its partners developed and released a farmer-to-farmer instruction video on *Striga* management strategies (see below photo). The 21-minute video shows four different principles that contribute to a reduction of *Striga* infestation: (i) Crop rotation or intercropping, including leguminous species, (ii) Direct seeding in previous crop residues without soil tillage, (iii) Fertilizing the soil with chemical and organic fertilizers, and (iv) The use of a *Striga*-resistant rice varieties. These first three practices also strongly benefit soil conservation and soil fertility. Farmers describe in their own words their experiences with these practices and explain why and how it is done. The video is accessible online through YouTube and other platforms as well as on a DVD and has initially been produced in five languages: French, Malagasy, English, Swahili, and Portuguese.

(https://www.youtube.com/watch?v=EguvQQDV1Wo&feature=youtu.be)

Figure 9. Video on Striga *management fordissemination.*

3. Out-scaling of the ASI Thresher

More than 90 Agricultural Transformation Agenda Thresher cleaner (ATAT/ASI) threshers have been manufactured and delivered in Nigeria.

Figure 10. Mini- ASI Thresher suitable 800 kg/h.

4. GEM rice parboiling complex installed in Benin (Glazoué and Malanville) innovation platforms (IPs)

In the Malanville IP (North of Benin), the parboiling technologies installed are for medium-scale operation 500 kg/session and are on a 225 square meter area. A solar panel and bulbs were installed to provide electricity for lighting and charging of mobile phones as an additional incentive to the IP actors (women rice processors) who are the direct beneficiaries. This system will later serve to power fans for husk gasification systems. All installed components were tested and are working well. The GEM rice parboiling complex comprises stoves, labor-saving devices, and drying surfaces in the Malanville IP.

In Glazoué IP (center of Benin), the parboiling technologies installed are for medium-scale operation (400–800 kg/day) and are on a 9 by 24 square meter area (Fig. 13). The shed is connected to electricity supply from the nearby UNRIZ-C (farmer organization) building. The system was tested by the beneficiary women as well as the youth group on 22–23 May 2015 by cleaning, soaking, steaming, and drying 280 kg of paddy (Fig. 13). Table 1 shows that women processors in the Glazoué IP doubled the amount of parboiled rice (kg parboiled rice in a month) and nearly tripled their income from the sale of the parboiled rice. Over 90% whole grains and very little impurities were obtained with the GEM and training.

Figure 12: GEM Complex and Women parboilers in Malanville using the equipment

Figure 13. Women using the GEM parboiling system in the Glazoué IP.

Table 1. GEM parboiling system on average production, income and grain quality of parboiled rice in Glazoué innovation platform.

	Production (Kg)/month	Income (FCFA)/ month	Heat damaged grains (%)	Whole grains (%)	Chalky center (%)	Impurities
Parboiled rice without GEM & Training in IP	1603	797,250	23.9	60	> 20	> 5
Parboiled rice with GEM & Training in IP	3489	1,744,750	2	91	0	0

5. Establishment of Innovation Platforms in the rice hubs in Benin

Innovation Platforms (IPs) in the rice value chain within the rice sector development hubs have started to enhance the quality of interaction, relationships, confidence, and trust, as well as businesses among rice value chain stakeholders. This is influencing local decision making processes in policies and institutions, and has started to contribute to improved livelihoods and institutional change among the diverse social and economic operators in the rice value chain (Table 2).

Table 2. Changes brought about by Innovation Platforms (IPs) in rice value chain in the Glazoue rice hub (Benin).

	Change brought by Innovation Platforms (IPs) in rice value chain	
Stakeholder	**Before IP**	**With IP**
Farmers/Producers	3.5 t/ha	5 t/ha
Women Parboilers (Bantè IP)	1 t paddy/month (during harvest)	10 t paddy/month (during harvest)
ESOP processor (Bantè IP)	1.5 t paddy/day (during harvest)	5 t paddy/day (during harvest)
Processors (SONAPRA Millers)	500 t paddy (during harvest)	1000 t paddy (during harvest)
Traders	Sold 15 t/month	Sold 20–25 t/month
Mini Rizerie (Glazoué IP)	25% increased income	50% increased income
Extension (CARDER)	Reached 100 rice farmers	Reached 250 rice farmers
NGO-MRJC	Reached 4 villages	Reached 9 villages
MicrofFinance (CLCAM)	CFA 10 million	CFA 21 million
Policy (Local Government)	Cotton + Maize as cash crops	Cotton + Maize + Rice as cash crops

Figure 16. Malanville IP actors at the meeting.

The establishment of IPs in the Glazoué rice Hub encouraged farmers and entrepreneurs to participate in the rice value chain as an additional source of income. The introduction of IPs in the Glazoué and Bantè areas caused a significant local policy shift to support rice value chain development: (i) The Mayor in Glazoué linked projects (new and old) with the IPs and allocated a stall to the rice processing (parboiling) group within the IP to facilitate the marketing of locally parboiled rice; (ii) The Mayor promoted the sale and consumption of locally parboiled rice through contractual arrangements with women parboilers; (iii) The Mayor in Bantè allocated land to the ESOP rice processor group in the IP to construct their processing unit; (iv) The IP has been advocating for additional support from the Mayor in Bantè to ESOP and other rice value chain actors in the IP.

An innovation platform was also established in Malanville in the irrigated ecology in north Benin. The IP actors were identified and an IP coordination and facilitation team was institutionalized. The IP coordination and facilitation team comprises the representatives of the extension service, seed producers, paddy producers, parboilers, traders, brokers, a microfinance, and policy maker (mayor). The entry points are milled rice and parboiled rice to improve the marketing of local produced rice.

6. Promoting locally produced rice in urban markets through the innovation platforms in Benin

L'Union des Riziculteurs du Centre (UNIRIZ-C)–République du Benin, produces two categories of rice: milled rice and parboiled rice. The quality and quantity of the parboiled rice has been improved by using the GEM parboiling system installed recently by SARD-SC/AfricaRice. Both products are supplied in 5-kg packs with the trademark "Saveur". Since 2013, UNIRIZ-C has participated at the fair organized every year to celebrate Benin's Independence Day. For the 2015 fair, the SARD-SC project facilitated UNIRIZ-C's visibility by providing an advertising tarpaulin, posters, flip charts, a video projector, and a computer. A non-governmental organization (VECO BENIN) also supported UNIRIZ-C by donating T-shirts imprinted with images of "Saveurs" rice processed by UNIRIZ-C. The presentation equipment (computer, projector, flip charts) helped to project the image of women parboilers in UNIRIZ-C and attracted many curious persons and customers (Fig. 17).

Figure 17. Customers visiting the stand watching and listening to the explanation from the sellers.

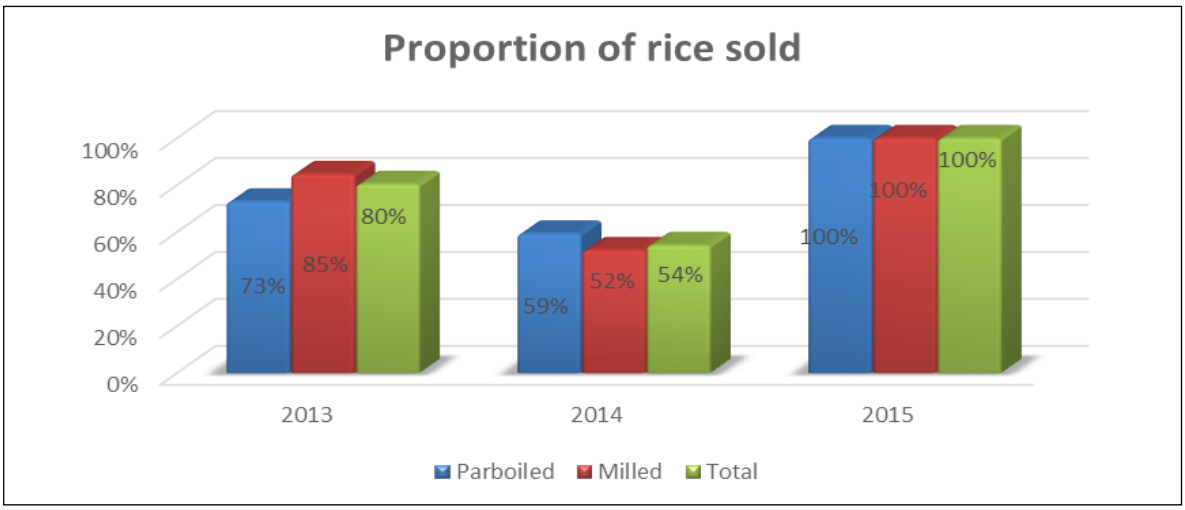


Figure 18. Proportion of rice sold by UNIRIZ-C during Independence Day trade fair.

During the 16 days of the fair, UNIRIZ-C's stand received 670 visitors, including 321 women (47.91%), with an average of 78 per day. All the rice brought to the trade fair was sold in 2015, which was not the case in the previous years (Fig. 18). With modern marketing tools the sale of Riz "Saveur" increased strongly by 90% and 173% compared, respectively, to 2014 and 2013 (without AfricaRice support).

UNIRIZ-C showed its appreciation of the impact of these publicity materials in the following words: "This fair was the first and the best for us (in terms of attendance and sales). Since we have been participating in fairs, our rice has never been so visible and appreciated as in 2015. As evidence, a week after the fair, through the contacts made at the fair, we delivered 625 kg in Cotonou ~~33~~0 kg of parboiled rice and 295 kg of white long grain rice. The publicity during the fair attracted several stall-keepers to the booth where they asked questions about the parboiling process that was used to produce the rice on display. Once again, thanks to AfricaRice/SARD-SC.

7. Support with branding and packaging to the smallholder processors in the Glazoué IP in Benin

To enhance consumer's attractiveness to locally produced rice, an enhanced new packaging/ branding and labelling of parboiled and milled rice in Glazoué IP in Benin was undertaken with the active participation of the IP actors (Figs. 19 and 20).

Figure 19. New packaging developed for Parboiled rice "Riz Saveur".

Figure 20. New packaging developed for non-parboiled rice "Riz Saveur".

8. Technology and innovation dissemination in partnership with CORAF–WAAPP

A technology and innovation workshop was held at the Africa Rice Center (AfricaRice), Cotonou on 5 and 6 October 2015, to inform and educate CORAF-WAAPP constituents on scalable technologies for dissemination in the WAAPP countries. There were 47 participants (30 from nine WAAPP countries, one from the World Bank Abidjan office, three from CORAF, and others). Not surprisingly, NARS participants widely selected improved varieties for dissemination. Other key technologies and innovations selected include the ASI thresher, weeders, and GEM rice parboiler.

9. 1st AfricaRice/private seed enterprise consultative workshop

A two-day (15 and 16 October 2015) workshop was held at the AfricaRice station at M'Bé, Côte d'Ivoire under the auspices of the AfDB-funded SARD-SC project. It brought together entrepreneurs of 31 small-to-medium (SMEs) seed enterprises from 13 countries (Benin, Burkina Faso, Côte d'Ivoire, Ethiopia, Ghana, The Gambia, Madagascar, Mali, Niger, Nigeria, Senegal, Tanzania, and Uganda), breeders from the NARIs of SARD-SC countries, scientists from AfricaRice, a CORAF representative, and a rice miller to deliberate on how to improve on functional rice seed systems in sub-Saharan Africa. The purpose was to facilitate access to certified rice seed of improved rice varieties by smallholder rice farmers many of whom are women.

10. Sustainable capacity strengthening of project stakeholders

The key trainings undertaken were in the areas of integrated rice management (IRM), mechanization, marketing, multi-stakeholder processes in value chains (innovation platforms [IPs]), contractual arrangements, M&E and impact assessment ,and knowledge management. Accountants from NARIs were trained on accounting and budgeting to enhance the quality and efficiency of financial reporting on project funds by the NARIs to AfricaRice. Furthermore, hands-on skills enhancement through on-site coaching and mentoring of NARI accountants was adopted. This was found to be most effective in enhancing the competencies and skills of the NARI financial staff. It also improved the rate of project fund justification by the beneficiary countries.

PhD training: PhD fellowships were awarded to seven students (28.6% female), from Benin, Ghana, Nigeria, Togo, and Uganda to undertake thesis research on rice through joint supervision by African Universities and AfricaRice. Although Togo is not a SARD-SC rice country, the Togolese scholar is based in Senegal and thereby qualifies for the fellowship. The AfDB endorsed these fellowships on 5 February 2014. The seven PhD students, two University supervisors and all the AfricaRice supervisors participated in a SARD-SC rice fellowship orientation and planning meeting held at AfricaRice, Cotonou in October 2014.

MSc Training: So far, twenty-two (22) MSc students (60% men and 40% women) from Benin, Côte d'Ivoire, Ethiopia, Ghana, Madagascar, Nigeria, Niger, Sierra Leone, Tanzania, and Uganda have been selected and some of them (Benin, Ethiopia, Ghana, and Madagascar) have commenced their studies.

Training of women and youth: About 1000 women rice parboiler households were trained in the use of GEM rice parboiler technology and innovation, through the Glazoué (rainfed rice ecology) and Malanville (irrigated rice ecology) innovation platforms (IPs). Also, 24 youths comprising 19 males and five females were trained in the GEM rice parboiling technologies and innovations through the Glazoué and Malanville IPs in Benin. Furthermore, eight youths out of 24 youth in Benin have been trained on the use and maintenance of equipment (milling machine, reaper, thresher, and power tiller).

Figure 21. IRM training in the field.

Wheat value chain

Wheat and Africa

"Africa's wheat imports constitute about a third of the continent's food imports' expenditure of US$45 billion," -FAO Stats.

Enhancing wheat competitiveness through developing and deploying high-yielding, heat-tolerant, and disease-resistant wheat varieties in African environments

SARD-SC Wheat is aiming to achieve transformational impact and sustainable increase of wheat productivity for enhanced food security, economic growth, and poverty alleviation in 12 sub-Saharan African countries. Enhancing the competiveness of wheat involves the development and deployment of appropriate technologies for targeted production environments and markets. Thus, efforts of SARD-SC Wheat have focused on developing **high-yielding, heat-tolerant, and disease-resistant wheat varieties** along with complementary crop, soil, and water management options that are suitable to the different wheat growing environments of Africa.

The project implementation including testing, validation, and generation of best-fit improved technologies are largely undertaken in the three typical and agroecologically representative "hub" countries (Ethiopia, Nigeria, and Sudan), and they are serving as a springboard to fast track transfer and dissemination of proven technologies to the other nine "partner" countries (Kenya, Lesotho, Mali, Mauritania, Niger, Tanzania, Zambia, and Zimbabwe).

During the year 2015, the successive field testing, evaluation, and validation of advanced breeding lines in different project target countries led to the identification 24 new

Wheat stakeholders impressed with performance of wheat crop during a recent wheat field day in Sudan.

and best-fit improved wheat varieties along with their crop, soil, and water management packages. These breeding lines were selected from the large number of elite breeding lines over 300 entries annually dispatched from ICARDA and CIMMYT to each of the participating countries. All introduced advanced wheat germplasm is subjected to multilocation testing and subsequent field demonstration at target Innovation Platform (IP) sites, where farmers, women groups, and stakeholders participated in the field selection of superior varieties based on various desirable (yield, quality, agronomic, disease and pest resistance) attributes.

Among the best performing varieties identified in 2015, 18 were officially released after being approved by the national variety release committee in the project target countries (five in Ethiopia, four in Nigeria, two each in Mali and Niger, and one in Mauritania). These varieties are high yielding (5–8 t/ha), widely adaptable, tolerant to heat stress, and resistant to the prevailing diseases and pests. The remaining 10 candidate varieties are expected to be released in different project countries during the coming 2016/17 season. In addition, a range of integrated crop/soil/water management packages, conservation agriculture, and crop rotation practices were widely verified and demonstrated to farmers and stakeholders across the project participating countries.

Performance the two newly released heat-tolerant wheat varieties in Kano State, Nigeria.

Wheat value chain

Nutritional and agro-industrial quality of the heat-tolerant wheat varieties

Millers' preference for imported wheat over local wheat produced in Africa has been based on a claimed superior grain quality of the former. In order to ensure the competitiveness and sustainability of domestic wheat production, it is imperative that the wheat varieties grown in Africa meet the required industrial quality parameters compared to the imported wheat. Therefore, present efforts in the SARD-SC Wheat project are focused on better characterizing the newly released wheat varieties for their nutritional, culinary, and agro-industrial qualities to meet the requirements or preferences of wheat millers, marketers, agroprocessors, and consumers.

Accordingly, all candidate pipeline wheat varieties passed through rigorous quality tests for their industrial milling and baking quality attributes before they were recommended for official release in project target countries. All these developments indicate an increased awareness of the importance of good quality wheat to gaining the support of millers, agroprocessors, consumers, and other stakeholders for local wheat production in African countries. Results have shown that the heat-tolerant, high-yielding wheat varieties are also endowed with excellent nutritional and agro-industrial characteristics, including high grain protein content and gluten strength.

Three samples of wheat varieties (Norman, Atilla, and Cettia) analyzed for quality and baking parameters in the laboratories of Honeywell flour mill at Apapa, Lagos and compared with Hard Red Winter wheat from the USA.

Delivering the seed

Employing diverse and accelerated seed production systems for rapid technology adoption and impact

The weak and ineffective wheat seed system is one of the serious challenges affecting effective dissemination and adoption of the newly released wheat varieties. To address this critical challenge, SARD-SC Wheat is promoting diverse and accelerated seed production systems through supporting and strengthening the formal public and private seed sector on one hand and establishing and expanding community-based seed production and marketing on the other hand with the objective of ensuring continuous access and supply of improved seed to smallholder wheat farmers for fast-tracking technology adoption and impact. Accordingly, during 2015 over 750 tons of initial seed (breeder, pre-basic, and basic seeds) of newly released varieties were produced in the three project hub countries

Harvesting of wheat seed in Sudan.

(Nigeria, Ethiopia, and Sudan) through an accelerated seed multiplication scheme by involving private seed companies as well as community-based seed producing farmers. For instance, in Nigeria alone over 138 tons of wheat seed was produced in 2015 compared to 34 tons in 2014. This additional seed was distributed to newly joining 680 seed producing farmers within the six Innovation Platforms, enabling the country's capacity to cover much of its 100,000 ha wheat areas with improved varieties.

In addition, Nigeria, being a hub country serving for the West Africa project target countries, also supplied 9 tons of certified wheat seed of Norman and Atila gan Atila varieties (3.5 tons to Mali, 3 tons to Niger, and 2.5 tons to Mauritania) in order to expand the production of wheat in these countries using proven high yielding varieties. Production and delivery of seed was also done from the ICARDA seed multiplication centers in Egypt, Ethiopia, and the Sudan to support the nine SARD-SC wheat project partner countries.

Distribution of postharvest bags in Kano State, Nigeria after postharvest training.

Postharvest handling: Poor postharvest handling costs Africa more than 25% of its harvest. The project is working to reduce this by 15% through training on harvest and postharvest handling, and popularizing the inexpensive PICs bags that can be locally produced. Thousands of farmers have been trained and provided with these bags. For example in Niger in May 2015, 558 female participants underwent such training. In Nigeria, 900 farmers from three locations were trained and provided with bags. Similar trainings were undertaken in Ethiopia and Sudan involving several hundred farmers.

Innovation Platforms: An effective approach for scaling out proven technologies and linking farmers to markets along the value chain

SARD-SC Wheat embraces Innovation Platform (IPs) as an effective approach for scaling out proven technologies and linking farmers to input and output markets with active participation of stakeholders along the wheat value chain including policy makers. The IP approach provides an excellent forum for bringing together all relevant value chain actors and for stimulating interactions, co-learning, exchanging experiences, and dialogue among stakeholders that lead to participatory diagnosis of challenges as well as joint exploration of opportunities and devising of sustainable solutions for promoting wheat production, processing, and marketing along the wheat value chain in the target countries.

In 2015, SARD-SC Wheat successfully operationalized 34 IP sites in 12 project target countries. These included six IP sites in each of the three hub countries (Sudan, Nigeria, and Ethiopia); and one or more IP sites in each of the remaining nine partner countries. Proven technologies (varieties with management packages) were widely demonstrated, scaled up, and promoted with the involvement of farmers & value chain stakeholders at each IP site. Accordingly, results from the technology dissemination and promotion across the 34 IPs clearly revealed that IP participating farmers who adopted the improved wheat technologies with associated packages significantly increased their wheat productivity from the current average yield of 1–2 t/ha to more than 4–7 t/ha across the project target countries.

During 2015, the project reached more than 25,000 direct beneficiaries, of which women accounted for 32 percent. The beneficiaries engaged in different segments of the wheat value chain including areas of wheat production, seed production, wheat processing, and marketing.

Business and job creation for women and youth in the wheat value chain

In 2015, special emphasis was given for organizing youth and women groups at the IP level and engaging them in various businesses through focused hands on-training and building the entrepreneurship skill of youth and women groups in areas of wheat production, processing, and marketing along the wheat value chain. The youth and women groups were engaged in various innovative businesses and jobs including

Organized youth and women groups with a cross section of farm equipment operating at Kadawa and Alkamawa IP sites of Kano State, Nigeria.

community-based seed production and marketing, certified seed production and marketing; agricultural service delivery in wheat production (input distribution, field chemical spraying, harvesting and threshing services); maintenance of different agricultural farm equipment, harvest and postharvest machinery; and value addition and marketing of various wheat-based products including packaging, labeling, branding, and marketing of products.

SARD-SC Wheat also provided some material support for businesses run by model youth and women groups in the three project hub countries. These include some basic equipment that is critical for the smooth running of businesses, such as knap-sack sprayers, wheat reapers, mechanical threshers, mechanical seed cleaners, and wheat value addition baking equipment. Currently the youth and women group led businesses are running smoothly providing job opportunities and income for the participating members. Such project interventions at the IP level are also attracting the interest of local administration and policy makers to replicate and expand similar businesses targeting youth and women groups in different areas of the country.

Examples of women groups attending a range of focused wheat value addition trainings in Ethiopia and Zimbabwe.

Wheat value chain

Farmer field days and travelling workshops–Powerful tools for scaling up transformative technologies

Wheat teams of the SARD-SC Project in all participating countries work very closely with IPs involving thousands of farmers and stakeholders along the value chain with the objective to fast track the adoption of proven technologies, thereby accelerating the pace of wheat commercialization in production, processing, and marketing. As part of the technology promotion activity, field days organized at the IP and expanding scaling up sites towards crop maturity, have proven to be very effective tools for enhancing positive interaction and fruitful exchange of experience and information on the performance of new technologies and for nurturing common vision among all wheat stakeholders, including farmers, researchers, extensionists, creditors, input providers, wheat processors, end users, and most importantly, policy makers.

Field days are serving as the most powerful event for convincing stakeholders on the performance of improved wheat technologies and for triggering important policy decisions favoring the expansion of domestic wheat production in African countries.

During 2015, SARD-SC wheat held a series of successive field days and technology promotion events in the three project hubs (Sudan, Nigeria, and Ethiopia) as well as nine partner countries (Kenya, Lesotho Mali, Mauritania, Niger, Tanzania, Zambia, and Zimbabwe,).

Farmers were extremely impressed by the performance of demonstrated varieties and cultural practices that contrasted with the local practice, especially with the present SARD-SC wheat initiative where improved technologies are used with an optimum package in a new set up of partnership. Farmers are able to realize wheat yields of up to 5–7 t/ha versus 2 t/ha for farmers' old practice in these areas. All participants were eager to participate in SARD-SC's innovative dissemination and scaling up activities.

During the field day events, the project awarded best performing model wheat farmers selected from each of the IP sites across target countries for successfully adopting the improved wheat varieties with

The Vice President of Sudan, the Federal Minister for Agriculture, and other policy makers in the Gezira Irrigation Scheme.

their recommended packages and for realizing yields exceeding 6–8 tons per hectare. These champion farmers from different countries are a shining example to other farmers and as a result they were awarded certificates and farm implements by policy makers in their respective countries. All field day events held in project target countries were widely covered through different media outlets, including national television, national and local FM Radio, and national newspapers. In 2015, over 25,000 farmers and stakeholders (15,250 males and 9750 females) participated in the various field day events organized across the 12 countries.

Policy involvement

The transformational achievements of SARD-SC Wheat in project hub countries convinced Government decision makers and led to key policy shifts favoring domestic production as a viable solution for reducing imports and ensuring national food security. In Nigeria, for example, wheat has been included as a priority in the Government's Agricultural Transformation Agenda. The private sector including the Millers' Association has been engaged to create a market for domestic wheat with minimum price guarantees for farmers, access to inputs and credit, and incentives for millers to buy domestic wheat. Further the government launched a nationwide scaling up program to expand the wheat area.

SARD-SC Wheat Traveling Workshop in the lowlands of Africa: Wheat transformation in the making

SARD-SC Wheat, in partnership with the Agricultural Research Corporation (ARC) of Sudan, organized an experience sharing and mutual learning Traveling Workshop in the lowland irrigated areas of Sudan, as a typical African lowland country, to demonstrate the successful experience of Sudan; how improved, heat-tolerant wheat technology can raise wheat production in the African lowlands despite the yield depressing heat stress that prevails in these areas.

The Traveling workshop was organized during 25 February through 2 March 2015 covering the three major wheat growing regions of Sudan

(Northern State, River Nile State, and Gezira State) with a total of 30 participants drawn from 11 project participating countries (Eritrea, Ethiopia, Kenya, Mali, Mauritania, Niger, Nigeria, Sudan, Tanzania, Zambia, and Zimbabwe) and ICARDA. The main objectives of the traveling workshop were: i) sharing knowledge and experiences and mutual learning on the performance of newly developed heat-tolerant wheat varieties on farmers' fields and ii) how integrated research for development and the innovation system approach could bring various stakeholders along the wheat value chain together to effectively diagnose challenges and jointly devise sustainable solutions to enhance wheat production in the Sudan and Africa.

The activities of the first day started in River Nile State, with a visit to a field at the Zaidab Innovation Platform (around 370 km north of Khartoum). The State Minister welcomed the participants and expressed the full support of the State government for SARD-SC activities and praised the great achievements of the project in such a short time. Different farmers' fields were visited where the Project-generated technology had been successfully adopted. In particular, a diligent farmer named Izzaeldin owning a 2.4 ha farm growing the heat-tolerant wheat variety Bohine realized a yield of 5 t/ha, as compared to 2 t/ha before joining the Project. His production will be used to plant 100 ha in the coming season. The day ended with a meeting with the Governor of the River Nile State, HE Gen. Elhadi Abdalla, in the presence of the Federal Minister of Environment and the Ambassadors of Qatar and Oman. HE expressed his support to farmers and all SARD-SC Wheat activities.

The second day of the traveling workshop, the participants visited fields of the Khur Argo Innovation platform within Northern State. The State Minister of Agriculture, HE Adil Jaafar met the participants and explained the potential for successful wheat production in the State. He led the visitors on a wheat field tour through the Khur Argo IP. The participants met several farmers in wheat fields, and attended a session of an ongoing women-farmer field school on wheat production and processing.

A farmer in the region said that he and other farmers in the neighborhood in the past were using unimproved or mixed seeds that resulted in very low yield. With the recent establishment of the IP at Khur Argo, IP participating farmers produced 5.1 t/ha in the season 2014/2015, in contrast to the low yield (1.7 t/ha) of the local "baldi" cultivar. He added "*I am very much convinced by the use of improved technologies*

and I am expecting even higher yield from my extended fields compared to the yield of the past season". The participants noted the clear shift in adoption of improved technology by all neighboring farmers.

At another stop, a farmer who adopted the heat-tolerant technology and achieved a yield of 5.2 t/ha explained the useful benefits of farmer field schools (FFS) established by the SARD-SC Wheat team in *Dibtoud* village.

On the third and fourth days in Northern State, participants had the chance to interact with model farmers and visited wheat fields and production sites of the Agricultural Department of Hamadab Dam Authority where several IP participating farmers witnessed a dramatic boost in their farm level productivity from the existing 2 t/ha to 5–6 t/ha due to SARD-SC wheat interventions. On the following day of the traveling workshop, the participants joined the official field day tour and attended the field day ceremony at Al Basatna Innovation Platform in the Gezira Scheme.

Prior to the field day ceremony, the participants visited two field sites in Al Basatna IP, the first one was Radhma where a transformational change has been occurring in the IP sites as a result of collaboration among financing organizations (Gezira Microfinance and Agricultural Bank), the Gezira Scheme Extension Unit, and the ARC through SARD-SC Wheat project. The second site was at El Kumur where a farmer has been consistently obtaining high yield (5–6 t/ha) regardless of the seasonal variation in temperature, proving that farm management is a crucial factor for high wheat productivity under heat stress conditions. Participants observed in his farm the excellent performance of two popular and leading varieties (Imam and Argine) in addition to two recently released varieties, Goumria and Zakia.

During the last day of the travelling workshop, several high-level policy makers from Sudan and ICARDA officials attended the field day event organized by SARD-SC Wheat. Guests of Honor on the field day included HE the Vice-President, Hassabo Mohamed Abderahman; HE the Federal Minister of Agriculture and Irrigation Eng. Ibrahim Mahmoud Hamid Wali; HE. Mohamed Yousif Ali, State Minister of Agriculture. More than 500 farmers attended the field day where several speeches were given starting with that of the DG of ARC Prof. Ibrahim Adam Eldukheri, followed by the Representative of the Farmer Union, the Director of the Gezira Scheme, the ICARDA Director General, the Federal Minister of Agriculture, the Gezira State Governor, with a closing speech by HE the Vice-President of the Republic of Sudan. He promised to provide credit, necessary inputs, and extension services to further strengthen wheat production in the country. He also indicated that from what was seen, the country will move forward to produce its wheat needs and confirmed government support to research and production of food crops, especially wheat.

The Vice President and the Federal Minister of Agriculture raised a vote of thanks and appreciation to ARC and ICARDA for their efforts, leadership, and technical support. All speakers at the ceremony expressed their gratitude and thanks to all stakeholders who contributed to the successful efforts to enhance local wheat production. Farmers were strongly encouraged to continue their efforts to further boost yields and expand the wheat area to meet the national needs for this strategic commodity.

SARD-SC Wheat policy impact in project target countries

The impressive performance of high-yielding, heat-tolerant, and disease-resistant wheat varieties with agronomic packages that resulted in doubling and even tripling of wheat yields in the project hub countries (Sudan, Nigeria, and Ethiopia) has convinced decision makers that a viable solution to their country's growing dependence on unsustainable wheat imports is domestic production; a policy shift that will protect African countries from the vagaries of global commodity markets and strengthen national food security.

Sudan: The successful experiences of SARD-SC Wheat in promoting wheat technologies at six innovation platforms (IPs) with yields ranging from 4 to 6.5 t/ha convinced the Government of Sudan and generated the following policy changes: i) the Government officially adopted the IP approach as its national agricultural technology extension program throughout the country for wheat and other major food security crops; ii) the Government created a market for domestic wheat with minimum price guarantees for farmers and incentives for millers to buy domestic wheat; and iii) the Government launched a national target to boost domestic production through expanding wheat area from the existing 137,000 ha to 600,000 ha over the coming 35 years.

Nigeria: The impressive performance of improved and heat-tolerant wheat varieties with yields of 5–6 t/ha (significantly more than 1–2 t/ha average of traditional varieties) convinced policy makers and generated the following key policy shifts: 1) Wheat has been included as a priority in the Nigerian Government's Agricultural Transformation Agenda; 2) Through the ATA program, the Government launched a nation-wide scaling up to expand the wheat area from 70,000 ha to 340,000 ha over the coming five years; 3) The Government created a market for domestic wheat with minimum price guarantees for farmers; and 4) The Government set a national target to reduce the country's unsustainable import burden by up to 50% in 2019. At current market rates, this reflects a saving of around $2 billion each year in import costs.

The President of Nigeria, together with the Federal Minister of Agriculture, the Central Bank Governor, and other policy makers launch the wheat planting season in Kebbi State in November 2015.

Nigeria's minister for agriculture, chief Audu Ogbeh at the wheat day.

The Sudan vice president and federal minister of agriculture meeting wheat farmers.

Project Steering Committee Members

Names	Organization	Email
Dr Yemi Akinbamijo	FARA	Yakinbamijo@fara-africa.org
Dr Ken Dashiell	IITA	K.dashiell@cgiar.org
Dr Sam Bruce-Oliver	AfricaRice	s.bruce-oliver@cgiar.org
Dr Catherine Mungoma	SCCI, Zambia	maize@zamnet.zm
Dr Mahmoud Sohl	ICARDA	m.sohl@cgiar.org
Dr Gloria Elemo	FIIRO	gloelemo@yahoo.com
Dr Fan Shenggen	IFPRI	f.shenggen@cgiar.org
Ambassador Phillip Idro	Upland Rice Millers Ltd	Idrophil@gmail.com
Mr Gadrissa Gobenna	G.G. Commercial Farm Products	g-gobenna@ethinet.et
Dr Chrys Akem(Secretary)	IITA	c.akem@cgiar.org
SARD-SC Project Implementation Unit		
Dr Chrys Akem	Project Coordinator	C.Akem@cgiar.org
Dr Sam Ajala	Maize Commodity Specialist	S.Ajala@cgiar.org
Dr Sidi Sanyang	Rice Commodity Specialist	s.sanyang@cgiar.org
Dr Marie Yomeni	Cassava Commodity Specialist	m.yomeni@cgiar.org
Dr Solomon Assefa	wheat Commodity Specialist	s.assfa@cgiar.org
Dr Issaka Amodou	Monitoring and Evaluation Specialist	I.amodou@cgiar.org
Mrs Zulfawu Yahaya	Procurement Specialist	Z.Yahaya@cgiar.org
Mr Seyi Fatokun	Accountant	s.fashokun@cgiar.org
Ms Adebola Adewole	Communications Specialist	a.adewole@cgiar.org
Mr Ebenezer Adenekan	Executive Assistant	a.adenekan@acgiar.org
Mr Ebenezer Olaleye	Assistant Accountant	e.olaleye@cgiar.org
Mrs Elizabeth Adeyemi	Administrative Assistant	e.adeyemi@cgiar.org
Maize Commodity Value Chain Team		
Dr Sam Ajala	Maize Commodity Specialist	S.Ajala@cgiar.org
Dr Ibrahim Dugje	Regional Systems Agronomist, Ghana	I.dugje@cgiar.org
Dr Silverstro Meseka	Maize Breeder, Nigeria	s.meseka@cgiar.org
Professor Johnson Onyibe	Maize Country Coordinator, Nigeria	j.onyibe@cgiar.org
Dr Kwadwo Atwin-Obeng	Maize country coordinator, Ghana	K.atwin-obeng@cgiar.org
Dr NTji Coulibaly	Maize Country Coordinator, Mali	n.coulibaly@cgiar.org
Dr Medson Chisi	Maize Country Coordinator, Zambia	m.chisi@cgiar.org
Cassava Commodity Value chain Team		
Dr Marie Yomeni	Cassava Commodity Specialist	m.yomeni@cgiar.org
Dr Nhamo Nhamo	Cassava Agronomist, Zambia	n.nhamo@cgiar.org
Dr Veronica Uzokwe	Cassava Agronomist, Tanzania	V.uzokwe@cgiar.org
Dr Kokou Kincho	Cassava Agronomist, Dr.Congo	k.kincho@cgiar.org
Mr Sylvanus Fannah	Cassava Agronomist, Sierra Leone	s.fannah@cgiar.org
Dr Pheneas Ntawuruhunga	Cassava Breeder, Zambia,	p.ntawuruhunga@cgiar.org
Dr Mahungu Nzola Maso	Cassava Breeder, DR Congo	N.Mahungu@iitadrc.org
Dr Stefan Hauser	Root and Tuber Agronomist	S.Hauser@cgiar.org
Dr Bernard Vanlauwe	Natural Resource Management Leader	B.Vanlauwe@cgiar.org
Rice Commodity Value Chain Team (Project Implementation Unit)		
Dr Sidi Sanyang	Rice Commodity Specialist	s.sanyang@cgiar.org
Dr Kafu Ata Attisso Attiogbevi-Somado	Monitoring and Evaluation Specialist, Benin	K.Attiogbevi@cgiar.org
Abdou Mohammed Mouhidiny	Procurement Specialist, Cote D'Ivoire	M.Abdou@cgiar.org
Cheikh Sididya Abdella	Accountant, Cote D'Ivoire	A.Cheikh@cgiar.org
Ms Abiba Omar Mousa Abdoulaye	Research Assistant, Benin	ab.abdoulaye@cgiar.org

Task force coordinators and scientists

Dr Kazuki Satio	Agronomy Taskforce Coordinator, Benin	K.satio@cgiar.org
Dr Mutsa Masiyandima	Scientist, Senegal	m.masiyandima@cgiar.org
Dr Kofi Djaman	Scientist, Senegal	k.jaman@cgiar.org
Dr Jonne Rodenburg	Scientist, Tanzania	j.rodenburg@cgiar.org
Dr Elke Vandamme	Scientist, Tanzania	e.vandamme@cgiar.org
Dr Atkuso Tanaka	Scientist, Benin	a.tanaka@cgiar.org
Dr Arouna Aminou	Policy and Impact Assessment Coordinator, Benin	a.aminou@cgiar.org
Dr Rose Fiamohe	Scientist, Benin	e.fiamohe@cgiar.org
Ms Gaudiose Mujawamarya	Scientist, Tanzania	g.mujawamarya@cgiar.org
Dr Sali Ndindeng Atanga	Processing and value addition Coordinator, Benin	s.ndindeng@cgiar.org
Dr Ndiaye Kabirou	IRM Training Coordinator, Senegal	k.ndiaye@cgiar.org
Dr Jean Moreira	Mechanization Coordinator, Benin	J.moreira@cgiar.org
Dr Rita Agboh N	Gender Coordinator, Benin	a.agboh-noameshie@cgair.org
Dr Sie Moussa	Breeding Coordinator, Madagascar	m.sie@cgiar.org
Dr Kofi Dartey	Breeder, Liberia	k.dartey@cgiar.org

Wheat Commodity Value Chain Team (Project Implementation Unit)

Dr Solomon Assefa	Wheat Commodity Specialist	s.assefa@cgiar.org
Mr Hichem Hammami	Accountant	h.hammami@cgiar.org
Mr Khaled Essaidi	Procurement Specialist	k.essaidi@cgiar.org
Mr Ouambi Yameogo	Monitoring and Evaluation Specialist	0.yameogo@cgiar.org

Wheat Commodity Value Chain Research Team

Prof. I.U. Abubakar	West Africa Lowland Hub Coordinator, Nigeria	iuabubakar@gmail.com
Dr Izzat Tahir	East Africa Lowland Hub Coordinator, Sudan	izzatahir@yahoo.com
Dr Tolessa Debele	East Africa Highland Hub Coordinator, Ethiopia	tolessadebele@yahoo.com
Dr Osman Abdalla	Wheat Breeder, ICARDA	osabdalla@hotmail.com
Dr Habib Ketata	Wheat Breeder, ICARDA	h.ketata@cgiar.org
Dr Abdelaziz Niane	Seed Production Specialist, ICARDA	A.niane@cgiar.org
Dr Zewdie Bishaw	Seed System Specialist, ICARDA	z.bishaw@cgiar.org
Dr Aden Aw-Hassan	Socio-economist, ICARDA	a.aw-hassan@cgiar.org
Dr Yiguezu Yiguezu	Socio-economist, ICARDA	Y.Yigezu@cgiar.org
Dr Ali Chebil	SARD-SC Socioeconomic Specialist, ICARDA	a.chebil@cgiar.org
Dr Biradar Chandra	GIS Specialist, ICARDA	C.Biradar@cgiar.org
Mr Tesfu Isaac Ghebrendrias	SARD-SC Wheat Country Coordinator, Eritrea	tisak2003@gmail.com
Dr Mecharia Gethi	SARD-SC Wheat Country Coordinator, Kenya	mgethi@gmail.com
Ms Katleho Senoko	SARD-SC Wheat Country Coordinator, Lesotho	skatlewise@yahoo.com
Dr Oumarou Goita	SARD-SC Wheat Country Coordinator, Mali	coumbagoita@yahoo.fr
Mr Ahmed S. Marrakchi	SARD-SC Wheat Country Coordinator, Mauritania	asmarrakchy@yahoo.fr
Mr Soumana Souley	SARD-SC Wheat Country Coordinator, Niger	nsoumana@yahoo.com
Dr Oluwasina Olabanji	SARD-SC Wheat Country Coordinator, Nigeria	olabanji006@yahoo.com
Dr Zakari Turaki	Wheat Breeder, Nigeria	drturaki@yahoo.com
Mr Anthony Elanga	SARD-SC Wheat Country Coordinator, Tanzania	anthonyelanga@yahoo.com
Mr Julius Siwale	SARD-SC Wheat Country Coordinator, Zambia	siwalejulius@gmail.com
Mr Dumisani Kutywayo	SARD-SC Wheat Country Coordinator, Zimbabwe	dumisanikutywayo@yahoo.co.uk

About SARD-SC

Support to Agricultural Research for Development of Strategic Crops in Africa (SARD-SC), is a multi-national CGIAR- led project, which has the overall objective of enhancing food and nutrition security and contributing to poverty reduction in selected Regional Membership Countries (RMC) in Africa. The target RMCs are: Benin Republic, Cote d'Ivoire, DR Congo, Eritrea, Ethiopia, Ghana, Kenya, Lesotho, Madagascar, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Zambia and Zimbabwe. The project is funded by the African Development Bank and its focus is on raising the productivity and profitability of four commodities; Cassava, Maize, Rice and Wheat. These are four of the six commodities that African Heads of States have defined as strategic crops for Africa, through the Comprehensive African Agricultural Development Programme (CAADP). The overall objective of the project is to enhance food and nutrition security and contribute to poverty reduction in the Bank's RMCs. The specific objective is to enhance the productivity of and income from the four CAADP priority value chains on a sustainable basis. In real terms, the plan is to reduce food importation from other continents and offer farmers better access to markets, improve livelihoods and tackle poverty through enhanced capacities of beneficiaries in order to achieve sustainable development for the region.

Cassava fresh market at Shimoni - Zanzibar.

A heap of casava plants.

Lafia innovation platform members working on the GEM technology rice parboiler.

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