



Toward rice-based food systems transformation in Africa

Africa Rice Center (AfricaRice) – Annual Report 2019



AfricaRice

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Cover: Improving livelihoods and nutrition through productive and sustainable use of inland valleys, such as integrated rice-fish farming in Liberia (*inset*).

About Africa Rice Center (AfricaRice)

Africa Rice Center (AfricaRice) is a pan-African Center of Excellence for rice research, development and capacity building. It contributes to reducing poverty, achieving food and nutrition security and improving livelihoods of farmers and other rice value-chain actors in Africa by increasing the productivity and profitability of rice-based agri-food systems, while ensuring the sustainability of natural resources. AfricaRice is a CGIAR Research Center — part of a global research partnership for a food-secure future. It is also an intergovernmental association of African member countries. The Center was created in 1971 by 11 African countries. Today its membership comprises 28 countries, covering West, Central, East and North African regions, namely Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Côte d'Ivoire, Democratic Republic of Congo, Egypt, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Madagascar, Mali, Mauritania, Mozambique, Niger, Nigeria, Republic of Congo, Rwanda, Senegal, Sierra Leone, Togo and Uganda. AfricaRice headquarters is based in Côte d'Ivoire. Staff members are located in Côte d'Ivoire and in AfricaRice research stations in Liberia, Madagascar, Nigeria, Senegal and Uganda. For more information, visit www.AfricaRice.org

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AfricaRice

Message from the Board Chair and Director General

The year 2019 marked an important milestone for AfricaRice. The Center was co-awardee of the prestigious Al-Sumait Prize for African Development 2019 in recognition of the important role that it has played in enhancing food security in Africa. Its contributions include the development of new high-yielding and climate-resilient rice varieties, sustainable crop management options and gender-sensitive processing technologies — all of which are boosting incomes, food security and the well-being of millions of rural households in Africa.

The Al-Sumait Prize is administered by the Kuwait Foundation for the Advancement of Sciences (KFAS). The award is an indication of the determination and resilience of AfricaRice to respond to food security challenges in Africa, despite facing many difficulties over the years.

The award will help the Center to pursue its vision of its member countries achieving rice self-sufficiency, which will require a major transformation of rice-based food systems across the continent, from input supplies and land preparation, through the crop cycle, harvesting and postharvest activities, to marketing and food preparation, raising income levels and

creating resilience of the system itself. AfricaRice remains ideally placed to support its member countries in their efforts on all these fronts, as it engages in full partnership with national governments and their research-for-development executive agencies and, increasingly, with the private sector.

At the time of writing this report, the world is in the grip of the most significant pandemic for many generations. COVID-19 is wreaking global havoc on people's health and livelihoods. As the leading rice research and development institute in Africa, AfricaRice is mandated to help its member countries mitigate the impacts of the pandemic on their rice agri-food systems, by making quality seed and other improved technologies available, while working hand in hand with both public and private sector institutions, monitoring rice market trends and offering advice and guidance to policymakers.

Advocacy

During the Coalition for African Rice Development (CARD) side meeting at the Seventh Tokyo International Conference on African Development (TICAD) held in Tokyo in August 2019, AfricaRice presented its



Chair of the Board of Trustees, Carol Kramer-LeBlanc (right), with Director General, Dr Harold Roy-Macauley

perspective for CARD phase 2 and the Center's role in boosting the rice sector on the continent through focus on resilience, industrialization, competitiveness and empowerment.

In September 2020, at the 11th biennial consultation meeting of the AfricaRice National Experts Committee (NEC), which took place in Cairo, AfricaRice sensitized the directors general of national agricultural research institutions (NEC members) of 20 member countries on the current reforms within the CGIAR System Organization, including the AfricaRice–International Rice Research Institute (IRRI) unification process, and their implications for AfricaRice governance.

This resulted in the NEC endorsing the ongoing unification process between AfricaRice and IRRI, which will result in the formation of a single global rice research organization. Through discussion facilitated by AfricaRice, NEC members proposed a framework to strengthen partnership among AfricaRice member countries for improving rice production.

Research and innovation highlights

A major input for rice-based systems today is climate-smart varieties that raise the yield threshold and also have characteristics preferred by farmers and consumers. The first five varieties from the joint AfricaRice–Korea ‘Tongil’ breeding project have been released and more are in the pipeline as the project moves into its second phase (*see* page 6).

In 2019, AfricaRice conducted genetic ‘fingerprinting’ to determine the distribution of desirable genes among a collection of 130 popular varieties from 10 African countries. This knowledge is important for fast-paced varietal development (*see* page 7).

Once different technologies have been developed and validated, it is then vital to know whether they stand a good chance of success beyond the test sites. We have come a long way from simply observing agro-ecosystems

and thinking they look similar enough to where our technology is working. Today, we use complex, high-powered computer models to determine the similarity between sites and therefore identify where our new technology should work. This year, we report on one such approach for inland-valley systems (*see* page 8).

Soil fertility has always been a key concern for farmers. While industrial farming has moved into the realm of precision fertilizer application in large fields, AfricaRice has embarked on a new approach to rapidly assess soil fertility to aid soil fertility management (*see* page 10).

One of the keys to successful agricultural intensification is for farmers to adopt diversification. Adaptation research and disseminating tried-and-tested intensification and diversification options are being conducted in Nigeria, Rwanda and Senegal through the ‘Sustainable and diversified rice-based farming systems’ project (*see* page 11).

Marketing has for a long time been a major issue for rice value-chain actors. All too often locally produced rice is not competitive against imported rice. In the ‘Middle Rima Valley Irrigation Scheme’, Sokoto State, northwest Nigeria, AfricaRice helped establish the Goronyo Rice Innovation Platform and rice-processing facility. Suitable high-yielding cultivars with good grain quality have been identified to replace landraces and older cultivars, such as FARO 44, with a view to producing high-quality rice. AfricaRice is also facilitating contractual arrangements for market delivery (*see* page 12).

After a decade of research that led to the development of hybrid rice varieties, in 2019 AfricaRice provided the best of these varieties and appropriate training to private-sector seed enterprises in several countries under the ‘Technologies for African Agricultural Transformation’ (TAAT) Rice Compact. These partners are now running their own demonstrations and farmer field days to popularize the varieties in the farming communities they serve (*see* page 13).

Seed systems in sub-Saharan Africa have typically suffered from underinvestment from the public sector and seed business for self-pollinating crops, such as rice, have historically failed to ignite any enthusiasm from the private sector. As governments, businesses and communities have discovered the value of quality seed for good germination and a healthy crop, numerous schemes have been developed, especially at community level. Moreover, the private sector is now interested in rice seed. Again, under the TAAT Rice Compact, AfricaRice is modeling partnership with the private sector to multiply and distribute modern varieties (*see* page 14).

Agricultural value chains have huge potential to generate employment opportunities, especially for the youth of Africa. In Mali and Senegal, AfricaRice worked with the Technical Centre for Agricultural and Rural Co-operation (CTA) and the Syngenta Foundation for Sustainable Development, to help over 100 young agricultural entrepreneurs develop their business plans. Furthermore, AfricaRice trained more than 200 in information and communications technology for agribusiness, especially the use of social media (*see* page 15).

The ongoing need to raise the status of women is never far from the forefront of the research and innovation agenda of AfricaRice. The Center is helping to improve the livelihoods of women farmers in lowland areas of the Niore development hub, Senegal, by introducing stress-tolerant rice varieties (*see* page 16).

Rice variety WITA9 was developed by AfricaRice in Côte d'Ivoire and officially released in the country in 1998 — it was a true 'unsung hero', until now. Twenty years on, AfricaRice has conducted a multidisciplinary assessment of the variety to uncover the reasons for its positive impact on farmers' livelihoods in the country (*see* page 17).

Following on from the apparent success of doubling rice production in the 23 member countries of CARD over 2008–2018, the next goal set by the second phase is to double production again (to 56 million tonnes) by 2028 (*see* page 18).

New strategic projects

AfricaRice is witnessing the end of several high-profile projects funded by the Bill & Melinda Gates Foundation, including the 'Green super rice', 'Rapid mobilization of alleles for rice cultivar improvement in sub-Saharan Africa' and 'Stress tolerant rice for poor farmers in Africa and South Asia' projects. These projects focused on varietal development.

In support of the Center's efforts to modernize its breeding approach with a focus on improving genetic gain and product profiling of traits desired by consumers, the Gates Foundation is providing a bridging fund, with the intention of increasing its funding as we consolidate the approach with IRRI. This approach will also be supported by two CGIAR initiatives: the Excellence in Breeding platform program and Crops to End Hunger (CtEH).

A project funded by the International Fund for Agricultural Development (IFAD) for enhancing institutional breeding capacity to develop climate-resilient crops for African smallholders in Ghana, Senegal and Uganda, was launched in March, in concert with the project's first planning meeting. The 3-year project will be jointly implemented by the Integrated Breeding Platform (IBP) and AfricaRice, in partnership with national agricultural research systems (NARS), including national agricultural research institutions (NARIs), universities, seed enterprises and farming communities. The aim is to improve the effective distribution of improved varieties to farmers' fields.

A 3-year project 'Sustainable and Diversified Rice-based Farming Systems' under the 'Putting Research into Use for Nutrition, Sustainable Agriculture and Resilience (PRUNSAR)' program co-funded by the European Union (EU) and IFAD, was launched in July 2019 (*see* page 11). This project contributes to the 'Sustainable Farming Systems' Flagship Project of the CGIAR Research Program on Rice in Africa.

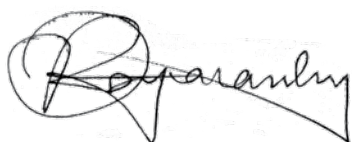
With support from IFAD, AfricaRice and the Africa Harvest Biotech Foundation International (Africa Harvest), in partnership with national programs, launched a 3-year project, ‘Strengthening the rice sector in East Africa for improved productivity and competitiveness of domestic rice’, in August 2019. The objective of this project is to enhance the performance of local rice value chains in Kenya, Madagascar and Uganda.

The project will adapt appropriate rice technologies and innovations to address emerging rice value-chain constraints, strengthen functional linkages among key rice stakeholders using multi-stakeholder innovation platforms, and improve the capacity of farmers and other rice value-chain actors, including input dealers, millers and marketers. Following an agreement with the Government of Uganda, a project office was established in July in Kampala, hosted by the National Crops Resources Research Institute of the National Agricultural Research Organisation (NARO) of Uganda.

The German Federal Ministry for Economic Cooperation and Development (BMZ) is funding a 3-year project on ‘Improved incomes and better nutrition in East and Southern Africa through rice parboiling and by-products use’ in Madagascar, Mozambique and Uganda.

Financial situation

At the end of year 2019, the Center recorded a surplus budget of US\$ 0.133 million for the second consecutive year of its 3-year financial recovery plan (2018–2020), and all AfricaRice financial indicators had reached CGIAR recommended targets.



Harold Roy-Macauley

Staff matters

A staff engagement and satisfaction survey conducted in October recorded 88.8% staff participation. The survey assessed staff engagement, values and culture, gender diversity and inclusion, leadership, communication, management, welfare, performance management, safeguarding and rewards.

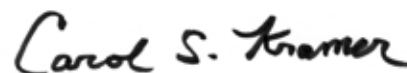
This resulted in the establishment of a plan for improving staff performance, which is currently being implemented.

One CGIAR and AfricaRice–IRRI alliance

The System Council of the CGIAR System Organization, at its November 2019 meeting in Chengdu, China, endorsed the recommendations of the System Reference Group, which was promoting a One CGIAR initiative around the following concepts: one mission; unified governance; institutional integration; new research modality; and more, and pooled, funding.

AfricaRice and IRRI pursued their discussions on the unification process, which involved strengthening the programmatic and institutional alliance between the two centers for more appropriate delivery of science that will respond to the developmental challenges faced by the rice sector in Africa.

Significant steps were made in defining the legal options of the alliance and aligning to the governance and management requirements of One CGIAR.



Carol Kramer-LeBlanc

Research and innovation highlights

New rice varieties and increased national breeding capacity — with help from Korea

The Korea–Africa Food and Agriculture Cooperation Initiative (KAFACI) ‘Enhancement of high-yielding rice germplasm and breeding capacity of rice producing countries in Africa by the Africa Rice Development Partnership’ project reached the end of its first phase in 2019.¹

In short, the project aims to introduce the advantages of Korean temperate *japonica* rice varieties into Africa by crossing superior Korean *japonica* and Korean ‘Tongil’ varieties with elite African *indica* varieties. Tongil materials are crosses between *indica* and *japonica*, so the new material is also Tongil.

Korean temperate *japonicas* bring desirable characteristics, such as high yield potential, strong stems, high milling recovery and medium to low amylose content for softer cooking (especially when cooled) — characteristics favored by farmers and consumers in many parts of Africa. ‘Ideal’ Tongils combine the best characteristics of temperate *japonicas* with the best characteristics of *indicas*, and the target is to breed 55 varieties for release among the 19 participating countries within the 9-year project timespan.

In its first 3 years of operation, the US\$ 400,000 Africa–Korea Rice Breeding Lab (AKRiL)¹ generated 77,049 doubled haploid plants from 149 crosses of Korean Tongil and African elite *indica*, using anther-culture technique. From these, 10,808 doubled haploid lines have been evaluated in the field. Subsequently, five varieties have been released: two in Malawi for rainfed lowland, one in Mali for rainfed lowland and two in Senegal for irrigated systems. These varieties are all early maturing and out-yielded preferred local varieties in farmers’ fields.



National breeders from (left to right) Mali, Tanzania, Democratic Republic of Congo and Gabon selecting promising KAFACI lines at the AfricaRice experimental farm in Ndiaye, Senegal

The Malawi and Senegal releases are all semi-dwarf, while the Mali release is of medium stature (preferred in rainfed lowlands prone to flooding). They also all have improved milling and cooking characteristics. Other project-developed lines are in national performance trials and in the pipeline for release in Ghana, Kenya, Malawi, Mali, Sudan and Uganda.

In 2019, the Korean Rural Development Administration rice breeder formerly based at AfricaRice Ndiaye/Saint-Louis, Kang Kyoung-Ho, noted that national partners were struggling with field-trial protocols for the new materials. Consequently, the project initiated 4-month, on-the-job training in breeding, anther-culture, experimental design and data analysis. The training follows the full cycle from seed to grain, and two batches of five national junior breeders participated in the course in 2019.²

Contacts: Kang Kyoung-Ho, Senior breeder, Rural Development Administration, Republic of Korea <khkang@korea.kr> and Baboucarr Manneh, Regional representative, Senegal, and Irrigated rice breeder, AfricaRice <b.manneh@cgiar.org>

1. For more information on the KAFACI rice project and AKRiL, see ‘The next generation of rice varieties for the lowlands in the making’, *AfricaRice annual report 2017*, pages 10–11.
2. Because of the international lockdown imposed to control COVID-19, the second two courses to reach the remaining nine countries have been postponed until 2021.

Finding sources of desirable genes for breeding programs

The response of rice to constraints is location specific and not necessarily the same everywhere. One of the goals of ‘pre-breeding’ is to identify traits in certain rice plants that confer an advantage in specific environments, against specific constraints, and to know how these may be incorporated into elite materials in the breeding program.

One such method is genetic ‘fingerprinting’, whereby specific molecular markers are used to detect the presence of specific genes. In 2019, AfricaRice collected 130 popular rice varieties in 10 African countries and fingerprinted them using 96 single-nucleotide polymorphisms (SNPs) for 43 quantitative trait loci (QTLs) or genes related to 20 traits.

Just three QTLs for three traits were almost ubiquitous, being found in over 90% of the varieties; if the parental lines have these traits, there is every chance that a high proportion of the offspring will as well, so no specific breeding strategies are required to ensure new varieties have them.

QTLs/genes for a number of traits were found in 25–83% of the varieties. These genes are not rare and should be easy to ‘pyramid’ (bringing together a number of QTLs/genes) into new varieties via marker-assisted selection.

QTLs/genes for four traits were scarcer, occurring in just 5–20% of the varieties. These would need to be ‘augmented’ (crossing donors with elite genotypes to increase their frequency in parental lines for the breeding program) to ensure their transmission into new varieties.

Certain QTLs/genes for several traits were very rare or absent from the collection, occurring in less than 2% of these popular varieties. These would require introgression into adapted varieties to create new donor parents for the breeding program.

Contact: Dule Zhao, Genetic Diversity and Improvement Program leader <d.zhao@cgiar.org>

Box 1. Availability of useful traits in 130 popular rice varieties and breeding strategy

Common, near-fixed traits (>90% of varieties): No special breeding strategy

- Anaerobic germination (germination in oxygen-poor soil)
- Reproductive-stage drought tolerance
- Seedling cold tolerance

Common (25–83%): Pyramid through marker-assisted selection

- Anaerobic germination*
- Bacterial blight resistance
- Blast resistance
- Days to heading
- Grain quality (chalkiness; gelatinization temperature; grain shape–size)
- Grain yield components (including number of grains)
- Herbicide resistance
- Reproductive-stage drought tolerance*
- Seedling salinity tolerance

Rare (5–20%): Augmentation

- Aroma
- Blast resistance*†
- Reproductive-stage heat tolerance
- Seedling cold tolerance*

Very rare or absent (<2%): Introgression to create new parental lines

- Amylose content
- Bacterial blight resistance*†
- Days to heading*
- Grain shape–size*
- Insect resistance
- Panicle structure
- Reproductive-stage drought tolerance*
- Rice yellow mottle virus resistance
- Seedling salinity tolerance*
- Submergence tolerance

* Where a trait is included under different categories, different QTLs/genes are involved.

† Bacterial blight and blast diseases are extremely diverse and one resistance gene does not confer resistance to all variations.

Research and innovation highlights

Finding the best inland valleys for rice expansion in Benin and Togo

For over a decade, rice production and yield have been increasing in Africa. However, the continent as a whole still has to import about 50% of the rice needed to satisfy consumer demand. “After reviewing the statistics, it was obvious to me that the major increases in yield achieved in recent decades are never going to be enough for Africa to reach self-sufficiency, and that we are therefore going to need to expand the rice area,” says Elliott Dossou-Yovo, AfricaRice agriculture and climate change specialist. The logical place to start is Africa’s potential ‘rice bowl’, namely its inland valleys.

“Inland valleys are hotspots for biodiversity and provide other valuable environmental services,” says Dossou-Yovo, “so the best option is to identify those inland valleys that would be best suited to rice, and then adopt best cultivation practices to maximize their rice production, so we can reserve the others for other uses.”

A team from AfricaRice, Ghana’s University of Energy and Natural Resources, the International Water Management Institute and University of Twente (the Netherlands) applied four environmental niche modeling approaches that use machine-learning algorithms and the presence of rice to determine the extent of suitable inland valleys in Benin and Togo.

The modeling predicted that 351,000–406,000 ha of Benin’s inland valleys are suitable for rice cultivation, corresponding to 41–47% of the country’s inland-valley area. The figures for Togo were 147,000–225,000 ha or 33–50%. Given current yield levels in rainfed lowlands, this means that about 60% of Benin’s suitable inland valleys and 54% of Togo’s would be needed to enable the two countries to reach self-sufficiency in rice; the rest could be reserved to other purposes, especially environmental services.

The models did not select the same set of inland valleys as suitable for rice cultivation (see Fig. 1). “Each model has its strengths and limitations,” says Dossou-Yovo,



Inland valleys are Africa’s potential ‘rice bowl’.

“which is why the modern trend is towards the use of several models to obtain a broader picture. It also means that even where there is consensus across two or three models, we need verification on the ground.”

From an original pool of 60 variables (known as ‘covariates’) for which data were available, 22 were selected to calibrate and validate the models. After modeling, 12 key covariates were identified for their strong influence on the likely suitability of a given inland valley for rice cultivation. These have been developed into a checklist that is used in the field to determine the actual viability and whether AfricaRice will recommend rice introduction to certain inland valleys.

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Agriculture and climate change specialist
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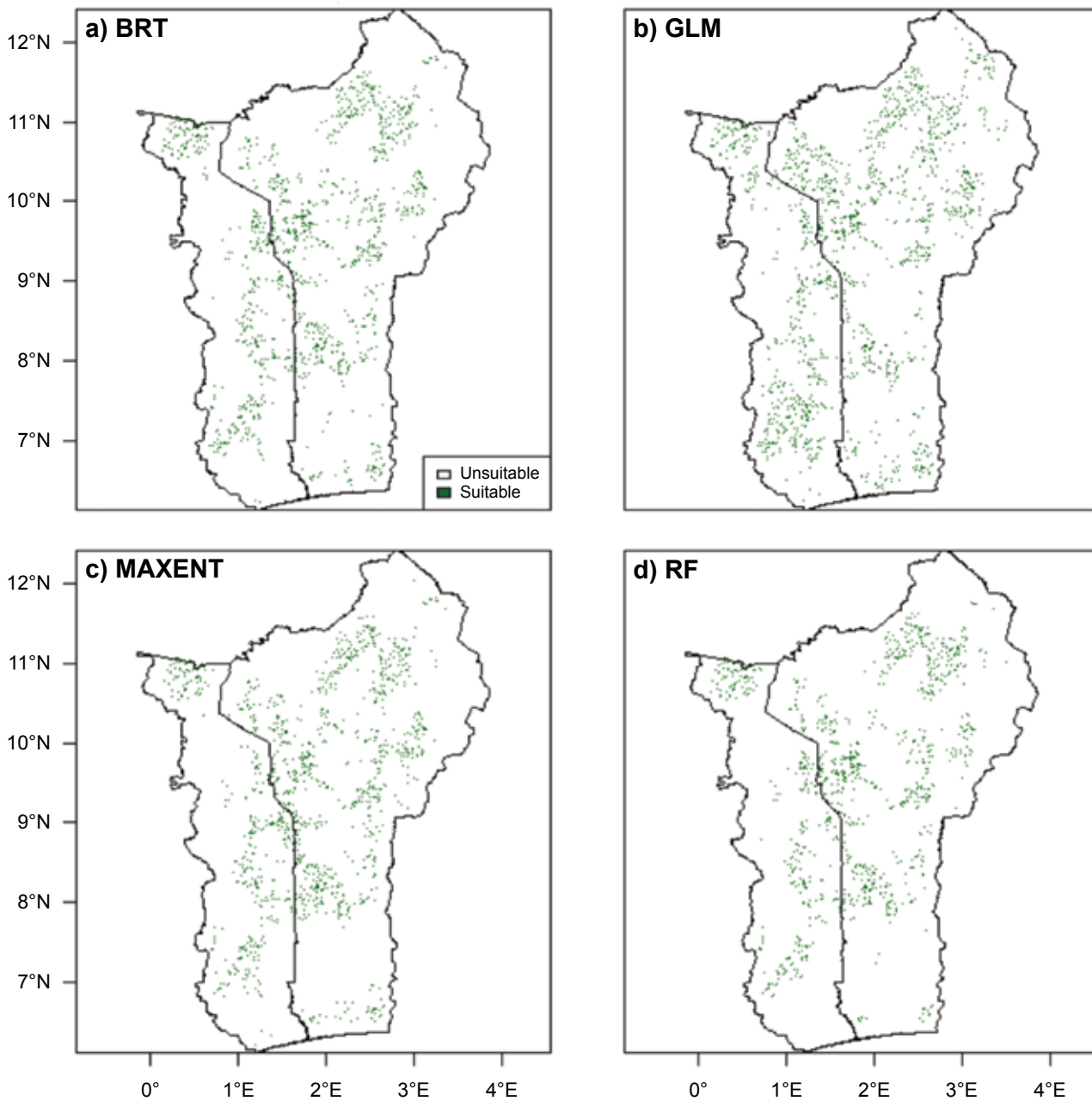


Figure 1. Binary maps showing predicted suitability of inland valleys for rice production from four models: (a) Boosted Regression Tree, (b) Generalized Linear Model, (c) Maximum Entropy, and (d) Random Forest

Research and innovation highlights

Using light to save time and money in soil analysis

To the lay person, light science is probably something they relate with their schooldays or reflect on when they see a rainbow. To some scientists, however, it is an everyday part of their work. Space science, for example, involves analyzing light from space to determine how far stars are from Earth, and even the chemical composition of stars, nebulae and distant planets.

“Laboratory analysis of soil is time-consuming and costly,” says AfricaRice extension agronomist Senthilkumar Kalimuthu. This is because the soil has to be analyzed separately for each property and some of the tests take considerable time. “So, we wondered whether we could use light science to speed up the process and save money as well.”

AfricaRice, together with partners in 20 sub-Saharan African countries, has collected over 7,500 soil samples. Ideally, all the samples require analysis to determine their properties and fertility levels for rice cultivation. But to attempt to analyze them all by traditional methods would not be efficient use of the Center’s limited resources.

Former soil lab manager, Jean-Martial Johnson (currently a PhD student at the University of Bonn), was tasked with performing analyses on 2,845 of the samples using a Fourier-transform infrared spectrometer to test the hypothesis that near- and mid-infrared light reflected by the sample may be a good predictor for some of the soils’ physical and chemical properties.

Ten percent of the samples were also subjected to full laboratory analysis by traditional methods, and statistical analysis performed on the traditional and infrared results to develop prediction models



The Fourier-transform infrared spectrometer Tensor 27 (Bruker Optics, Karlsruhe, Germany) with a high-throughput screening extension unit used for the near- and mid-infrared light soil analyses

to estimate soil fertility properties. The research team discovered that suitable analysis of near- and mid-infrared reflectance of soil samples was a good predictor of 13 soil properties of interest in soil fertility management and a “satisfactory predictor” of 6 more.³

“What this means is that we have a simple test for determining 13 soil properties that will save us a lot of time and money in soil analysis,” says Johnson. Moreover, “the test also provides data that may be sufficient for rough estimation of six other soil properties, depending on what needs to be known about a particular soil sample and how accurately it needs to be known.”

Contact: Kazuki Saito,
Agronomist and Flagship leader for sustainable farming
systems, RICE CRP <k.saito@cgiar.org>

3. Johnson JM, Vandamme E, Senthilkumar K, Sila A, Shepherd KD and Saito K. 2019. Near-infrared, mid-infrared or combined diffuse reflectance spectroscopy for assessing soil fertility in rice fields in Sub-Saharan Africa. *Geoderma*, 354: 113840. DOI: 10.1016/j.geoderma.2019.06.043.

Bringing intensification and diversification to more rice-based systems

Contributing to the CGIAR Research Program on Rice Agri-food Systems flagship project ‘Sustainable farming systems’ in Africa, the European Union and International Fund for Agricultural Development (IFAD) are co-financing the ‘Sustainable and diversified rice-based farming systems’ project under their joint ‘Putting Research into Use for Nutrition, Sustainable Agriculture and Resilience’ (PRUNSAR) program. The project is delivering and disseminating on-farm intensification and diversification options for improved food and nutritional security and poverty reduction. Over 3 years (2019–2021), the project is expected to reach 30,000 beneficiaries in Nigeria, Rwanda and Senegal.

The twin key aspects of the project are testing technologies and scaling them out where they prove suitable. The project will provide spillover benefits for research and extension organizations in Côte d’Ivoire, where some of the technologies are being developed and tested.

On-station and on-farm field experiments were initiated in 2019 in these target countries to test promising intensification options, such as micronutrient application, perennial rice systems,⁴ new varieties including hybrids, water management practices, new crop calendars, weed management practices, crop establishment methods, machinery, and farm diversification options, such as rotation with vegetables and legumes.



Micronutrient omission trial in Rwanda

In 2019, advice on fertilizer use generated by RiceAdvice⁵ and other basic good agricultural practices was disseminated to 13,653 farmers in Nigeria and Senegal. The project also piloted one business model: the use of vouchers placed with input dealers that entitle farmers to access RiceAdvice for the fertilizers they purchase.

Talking at the project inception meeting at M’bé in July 2019, AfricaRice agronomist Kazuki Saito said, “We will pilot different scaling approaches, including some business models. We closely work together with national systems, including RAB [Rwanda Agricultural Board] from Rwanda, ISRA [Institut sénégalais de recherches agricoles] from Senegal and NCRI [National Cereals Research Institute] from Nigeria.”

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4. Perennial rice (PR) varieties were developed from interspecific crosses between *Oryza sativa* and *O. longistaminata* by Yunnan University, China. Because *O. longistaminata* is perennial, PR varieties can have strong ratooning ability and are expected to demonstrate better agronomic performance in ratoon cropping than usual annual rice (*O. sativa*). PR varieties successfully survive, regrow and yield better across diverse range of environments in southern China and Lao People’s Democratic Republic.
5. A recent impact assessment study shows that households with access to the RiceAdvice app have 15% higher yields and 20% more profits. See www.riceadvice.info/en/; Arouna A, Michler JD, Yergo WG and Saito K. 2019. One size fits all? Experimental evidence on the digital delivery of personalized extension advice in Nigeria. *Cordon Research Papers in Agricultural and Resource Economics*, Research Paper No. 201902. University of Arizona, Tucson, AZ. <https://cals.arizona.edu/arec/sites/cals.arizona.edu.arec/files/publications/CRP-201902.pdf>

Research and innovation highlights

Upgrading the rice value chain in Nigeria for competitive markets

Demand for rice in Nigeria totals about 5.7 million tonnes (Mt) a year, of which 1.6 Mt is imported at an estimated cost of \$1.6 billion. Moreover, local rice does not compete with imported brands in terms of quality and therefore sells at a significant discount.

AfricaRice is contributing to the World Bank- and Nigeria-funded 'Transforming irrigation management in Nigeria' project, specifically in value-chain development at the Middle Rima Valley Irrigation Scheme, Sokoto State, in the northwest of the country.

AfricaRice and the National Cereals Research Institute (NCRI) identified an urgent need to replace the most popular variety used in Middle Rima valley, FARO 44, which has poor yield and poor-quality grain. The project identified three varieties with high potential for the area: ARICA11, DANG⁶ and Sahel 134, all with agronomic and quality characteristics appreciated by farmers, processors and consumers.

The project determined that farmers and other value-chain actors were willing to organize themselves to improve value-chain functioning, and consequently established the Goronyo Rice Innovation Platform to introduce and market high-quality parboiled and paddy rice.

The platform brings together farmers, microfinance institutions, seed suppliers, agro-input dealers, production advisers, millers, aggregators/marketers, parboilers, consumers, equipment fabricators and policy-makers, enabling the formation of cross-group (vertical) and within-group (horizontal) linkages for efficient working. The hope is that the Goronyo platform will follow the success of the one in Lafia,⁷ Nasarawa State, which generated over NGN 65 million



Demonstration of mini-GEM at Goronyo

(\$181,800) from the sale of 218.15 t of parboiled rice in 2019.

To give the new platform a solid start, the project established a processing facility, following the pattern of other innovation platforms (IPs). The facility comprises 'ASI' thresher-cleaner, Satake SB10 mill, destoner, rice grader, GEM and mini-GEM⁸ parboiling equipment, drying and storage space, and a borehole for clean water.

The IP facility has been registered at the Corporate Affairs Commission of the Federal Republic of Nigeria as The Goronyo Rice Processing Ventures, with 130 members and initial capital of \$1,538. Since its establishment, the IP has processed around 23 t of paddy each month, generating \$3,800 revenue and \$584 profit. A complete switch from wood to rice husk as fuel saves an estimated \$30–40/t of rice that would otherwise be spent on wood.

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6. DANG is an improved rice variety collected from a farmer in Goronyo, Sokoto State, Nigeria.

7. See 'Improving the quality of parboiled rice', *AfricaRice annual report 2016*, page 19–20.

8. See 'Fueling the GEM with rice husk: Good for the household economy, the environment and health', *AfricaRice annual report 2018*, page 14.

Scaling out hybrid rice with TAAT



Field day to showcase the performance of hybrid rice varieties developed by AfricaRice, June 2019, M'bé, Côte d'Ivoire

The 'Technologies for African Agricultural Transformation' (TAAT) project is CGIAR's response to the African Development Bank's 'Feed Africa' agenda. Project interventions focus on the commodity value chains and 'enablers' (e.g. policy, water, soil fertility, capacity-building). TAAT is organized into a number of 'compacts', and AfricaRice leads the Rice Compact.

The Rice Compact focuses on rice technology delivery and institutional arrangements to efficiently disseminate and scale technologies and innovations in the rice sector development hubs of target countries. It uses the rice technology delivery infrastructure (riceTDI), which is framed around the TAAT regional technology delivery infrastructure.

Scaling up and out is facilitated through the riceTDI using multistakeholder innovation platforms (IPs) in the rice hubs. Private-sector operators, such as seed enterprises and millers, form the nucleus of the IPs with farmers, policy-makers and other rice value-chain stakeholders.

In 2019, AfricaRice identified its hybrid rice varieties as ripe for scaling. Almost a decade in the making, the Center now has a number of stable hybrids that typically out-yield conventional varieties. Moreover, Senegal had released AfricaRice hybrid AR051H as ISRIZ-09 in 2017. Under the Economic Community of West African States (ECOWAS) variety protocol,

ISRIZ-09 is now available for promotion in all countries that contribute to the ECOWAS variety catalog. AfricaRice also took the opportunity afforded by the project to promote three other hybrids.

Hybrid rice is perfect for private-sector investment, because farmers have to buy new seed each year. However, AfricaRice currently has to continue to produce the seed because of intellectual property right issues over the parent lines.

Seed production is done at AfricaRice's M'bé/Bouaké and Ndiaye/Saint-Louis research stations, and both stations hosted field days which private-sector seed companies, millers, farmers and policy-makers were invited to attend at their own expense. As a result, companies from Burkina Faso, Côte d'Ivoire and Mali, and the Togo national research institute chose to test the hybrids in farm-based demonstrations in their countries of operation.

AfricaRice provided company staff with technical training on good agricultural practices and supplied the seed, while the private-sector partners did the rest: set up demonstrations of the hybrids alongside the most popular local variety in collaboration with farmers, and ran their own field days to which they invited farmers. The field days are designed to raise awareness of the hybrids and create demand from farmers.

In the private-sector–farmer demonstrations in Côte d'Ivoire, farmers preferred AfricaRice hybrid AR606H for its market qualities. This variety yielded 10.3 t/ha in large (200 m²) fields. Thus, the first step has been taken toward releasing hybrid rice varieties to the private sector.

Latterly, companies in Mauritania, Nigeria and Senegal have expressed interest in establishing hybrid demonstrations in 2020.

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Research and innovation highlights

Getting rice varieties to farmers by working with the private seed sector

In recent years, there has been a distinct shift in emphasis in the way AfricaRice seeks to disseminate its varieties. In the past, we relied almost solely on national seed systems or, where they were absent, community-based systems. Today, we are increasingly working with private-sector seed enterprises. This is very much in line with the philosophy of the ‘Technologies for African Agricultural Transformation’ (TAAT) project.⁹

Through the TAAT Rice Compact, AfricaRice is encouraging national seed systems and (private) small- and medium-sized enterprises (SMEs) to work together to generate demand for quality seed from rice farmers and sell them certified seed to guarantee the quality of the rice they produce.

AfricaRice provides the SMEs with breeder seed, which they multiply to produce both foundation seed (for their own ongoing use) and certified seed (for sale to farmers). The national seed regulation agency monitors, provides quality control and certifies both foundation and certified seed. Some seed enterprises (e.g. Neema Agricole du Faso SA [NAFASO] in Burkina Faso) also provide on-site technical support.

In 2019, AfricaRice supplied 33.17 t of breeder seed of five mega-varieties to various SMEs in Burkina Faso, Côte d’Ivoire, Ghana and Mali. The varieties were IR841 (Agra in Ghana), NERICA 4, NERICA-L 19-*sub1*, ORYLUX 6 and WAB 638-1 (Akadi in Côte d’Ivoire). AfricaRice also supported the SMEs by providing training in good agricultural practices and other technical advice.

The SMEs set up demonstrations in local farmers’ fields and provided land preparation, seed, monitoring and extension, while the farmers provided day-to-day management. Farmers from the SME’s target region



Some of the 200 farmers who attended a NAFASO field day

were then invited to field days to generate demand for the varieties on show. The involvement of the national seed agencies enabled them to verify research-based on-station and on-farm results with results from farmers’ fields under farmers’ control.

From data supplied to date by the seed agencies and enterprises (NAFASO, Grace Agricole de Côte d’Ivoire, Crops Research Institute of the Council for Scientific and Industrial Research in Ghana and Faso Kaba SARL in Mali), we estimate that the SMEs produced 348 t of foundation seed and 21,750 t of certified seed in 2019. The latter being enough to cover 435,00 ha, reaching about 1.74 million farmers.

“The private seed sector is an efficient partner for quality seed and variety dissemination,” says AfricaRice Seed Unit coordinator Saidu Bah.

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9. See ‘Scaling out hybrid rice with TAAT’, page 13.

Getting young agricultural entrepreneurs on track in Mali and Senegal

Last year, we reported on the launch of the ‘Promoting Youth Entrepreneurship and Job Creation in West Africa’s Rice Value Chain’ (PEJERIZ) project, implemented in collaboration with the Technical Centre for Agricultural and Rural Co-operation (CTA) and the Syngenta Foundation for Sustainable Agriculture.¹⁰

In 2019, PEJERIZ, in collaboration with business incubation centers, helped 103 budding agripreneurs (including 39 young women) in Mali and Senegal to develop business plans to promote youth employment in the rice value chain. From these, the best 40 in each country received a grant from the project and co-financing from their respective national agricultural bank (Banque Nationale de Développement Agricole in Mali and Banque Agricole in Senegal) that covered 50% and 40% of the business plan budget, respectively. The youth entrepreneurs funded the remaining 10%. The incubation centers also provided support in the form of mentoring and follow-up.

The project also built youth capacity in information and communications technology (ICT) for agribusiness, covering areas from accessing information and opportunities through ICT, through social networking, collaboration via online conversations, collaboration in document creation, farm record-keeping using spreadsheets, online communities of practice, and using mobile apps for agribusiness. Before the training, just 3–13% of the of the 204 participants (65 young women) had experience in ICT for agribusiness, and afterward more than 70% said they would be willing to use ICT tools for communication and networking.

In advance of the post-project impact evaluation in 2020, a number of the young entrepreneurs were asked about their experience with the project.



Discussion with Koudia Diop in her store of milled rice ready for marketing, Saint-Louis, Senegal

Ms Bakhao Fall from Bokhol village in Senegal said, “with the profits from my paddy production activity, I was able to pay for two cows to diversify my businesses. The project grant that remains in my bank account will now serve as working capital for another rice production season. I had never taken credit with the bank before. Today, with the project, I have been able to build good relations with this institution, which even put me in touch with other partners to allow me to sell my agricultural products.”

Mr Bernard Doumbia, an agro-entrepreneur in Sélingué, Mali, is running a food processing enterprise for parboiled rice. He said, “The ICT training will not only allow us to develop our business plan, but also to be able to sell our products online, which will significantly increase our turnover and improve our relationships with our partners.”

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10. See ‘Youth entrepreneurship and job creation in West Africa’s rice value chain’, *AfricaRice annual report 2018*, page 15.

Helping women feed their households in Nioro hub, Senegal



Women and men producers evaluating rice yield at harvest to select best four varieties, Coular village, Toubacouta-Fatick Region, Nioro hub

In the villages of Kaolack and Fatick regions, in the Nioro rice sector development hub in Senegal, women are struggling to grow the principal staple crop needed to feed their households: lowland rice. Most of the more fertile uplands are used by the men to grow cash crops, such as groundnut.

The lowlands are becoming increasingly saline from seawater intrusion and experience iron toxicity, drought and flooding. The situation is becoming critical: women farmers are replacing rice with vegetables or abandoning lowland cultivation altogether and they do not have adequate access to uplands to grow alternative staples, such as millet or maize.

Lowland rice producers have been largely bypassed by formal rice sector development, which focuses mainly on irrigated and upland rice. While Senegal has formally released many varieties over the past two decades or so, most of those grown in the Nioro rainfed lowlands are not salinity tolerant.

Historically, women farmers have obtained quality seed of improved varieties from short-term projects and the

public–private extension service, Agence Nationale de Conseil Agricole et Rural (ANCAR), but these have been few and far between (the latest were in 2009 and 2013). Otherwise, these women rely on self-saved seed, a practice that is recommended for only one or two seasons before quality deteriorates markedly.

In 2019, AfricaRice gender researchers worked with their colleague breeders to establish on-farm trials of varieties tolerant of salinity, iron toxicity and drought in three villages that were still producing lowland rice. Farmers ranked the varieties at various stages throughout the crop cycle and tested them in their own fields. All non-salinity-tolerant varieties succumbed to salinity, but four salinity-tolerant ones performed well in terms of yield, farmer-preferred short cycle, and cooking and eating quality.

These varieties are expected to be good for lowland production across the Nioro hub zone. “The next step is seed production,” says AfricaRice sociologist Maimouna Ndour. “The farmers have now dedicated 4 ha of land to seed production in the rainy season of 2020.”

Having previously trained the farmers, ANCAR will provide technical assistance in certified seed production. The farmers are preparing to use 1 ha for each of the four selected varieties: ARICA11, ISRIZ-10, ISRIZ-11 and Sahel 210. AfricaRice will provide the foundation seed to initiate the local seed production enterprise.

“We will also identify suitable business models for the new seed producers to sell to other farmers and for farmers to sell any surplus grain they produce — both aimed at commercializing and extending the reach of the new varieties to the benefit of the whole region,” says rice value chain expert Gaudiose Mujawamariya.

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WITA9 — quietly improving farmers’ livelihoods in Côte d’Ivoire

AfricaRice variety WITA9 was released in Côte d’Ivoire in 1998. As far as AfricaRice was concerned, it then ‘remained in the shadows’ for almost two decades.

But, “In 2016 and 2017, upon AfricaRice’s return to its main research center, we started seeing WITA9 all over the country,” says AfricaRice impact assessment economist Aminou Arouna. In the intervening years, the spotlight failed to shine on this variety, which was overshadowed by the promotion and success of the NERICA varieties and the Ivorian conflicts from 2002 onwards. Commenting on the spread of the variety without in-country awareness-raising by AfricaRice, Arouna says, “it is a technology that responds to the demand.”

WITA9 was selected and released for lowland agro-ecosystems, primarily because of its resistance to *Rice yellow mottle virus* (RYMV), a devastating yet common disease in Côte d’Ivoire.

With AfricaRice researchers back in the country and with country-wide access to rice farmers, the decision was taken to conduct a multidisciplinary assessment of WITA9, covering agronomy, grain quality, disease resistance, adoption, impact on farmers’ livelihoods and consumer preference.

The research showed that WITA9 responds well to good agricultural practices, including appropriate fertilizer application, and confirmed its resistance to bacterial leaf blight, rice blast and RYMV. Compared with other varieties cultivated in Côte d’Ivoire, the impact assessment shows that WITA9 has a typical yield advantage of 0.7 t/ha and increases farmers’ incomes by \$91/ha per season.

The adoption rate was estimated at 24%; however, closer analysis showed adoption rates of 60% among farmers who had heard about WITA9 and 71% among farmers who had access to it. Adopters were typically



Farmers with WITA9 in their store

young farmers, farmers who had received training in rice cultivation and those who were members of a farmer group or association. This indicates that the potential impact of WITA9 is much higher, and that raising awareness of the variety and improving seed availability would go some way to reaching that potential.

Moreover, data from a widescale census of rice value-chain actors in Côte d’Ivoire in 2018 showed that 2,674 out of 8,032 rice farmers had cultivated WITA9 — that is a 33% adoption rate!

In terms of marketability, consumers are willing to pay a price premium for WITA9, equivalent to that paid for the lower end of the range of imported brands – this is a major achievement for a local rice. It is no wonder WITA9 is often called *Nimba* (‘easy money maker’) in Côte d’Ivoire.

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Research and innovation highlights

Are we on track for continental rice self-sufficiency by 2030? A look at the contribution of CARD phase I

The establishment of the Coalition for African Rice Development (CARD) was a direct response to the devastating impact the 2008 global financial crisis had on staple food prices in many African countries. CARD was initiated by the Government of Japan, and its principal actors were AfricaRice, Japan International Cooperation Agency and the national agricultural research systems of 23 African countries.

The objective of CARD was simple: to double rice production in a decade, from 14 Mt in 2008 to 28 Mt in 2018. In 2019, AfricaRice evaluated CARD's achievement and analysed a scenario to achieve rice self-sufficiency by 2030.

On the face of it, CARD achieved its objective and a little more: within the decade, rice production had increased in the 23 CARD member countries by 103%. "However, we had to ask, 'what was the real impact of CARD?'," says impact assessment economist Aminou Arouna, "because rice production would have increased even without CARD."

Using statistical methods that involved a 'counterfactual' (i.e. what would have happened in the absence of CARD), Arouna and his team determined that CARD could be directly credited with a 74% increase in rice production over the first decade of its activity. Moreover, projecting current trends through 2030 (the end date for the United Nations Sustainable Development Goals, and therefore a suitable target), the team determined that consumer demand for rice across the 23 CARD countries will amount to 49 Mt, but local production will be only 40 Mt, and funding the shortfall will cost \$5.8 billion/year — a far cry from continental self-sufficiency!

However, further calculations suggest that attainment of self-sufficiency is possible. "If we can increase yield

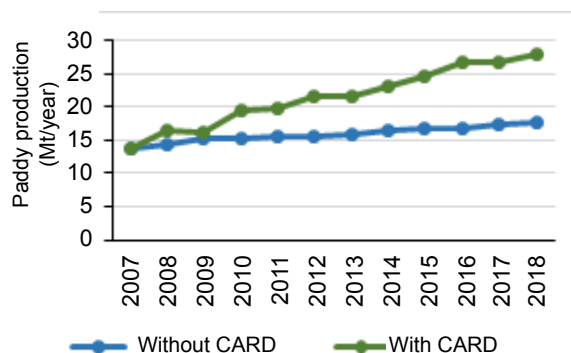


Figure 2. Comparison of paddy production with the CARD initiative and the counterfactual scenario

by 3% a year and area by 5.5% a year, we can make it," says Arouna. And the team think this is feasible because what it amounts to is increasing on-farm yield from 40% of potential yield (today's figure) to 56% and rice area from 12% of potentially suitable land to 23%.

Going back to the evaluation of CARD, the team found that the \$9 million investment accounted for only a third of the impact. "The key to the rest of the impact is targeted action," says Arouna. "For example, development and promotion of good agronomic and postharvest practices, and policies to upgrade the rice value chain. The value-chain approach means every stage is geared toward the market, quality has to be improved and standards reached and maintained. In short, value-chain actors have to work together."

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Finance

The AfricaRice management is pleased to report the improving financial situation of AfricaRice during the year ended 31 December 2019. The following are the highlights of the financial results.

Financial situation

The total operating revenues of the Center decreased from US\$ 17,481 million in 2018 to US\$ 17,005 million in 2019, corresponding to a decrease of US\$ 0,476 million. Operating expenses also decreased, from US\$ 17,177 million in 2018 to US\$ 16,884 million in 2019, corresponding to a decrease of US\$ 0,293 million. This resulted in AfricaRice recording an operational surplus of US\$ 0,121 million in 2019, compared with the operational surplus of US\$ 0,304 million in 2018. Additionally, the net non-operating financial expenses

reduced the annual surplus for the year to US\$ 0,083 million compared with the surplus of US\$ 0,158 million recorded in 2018. The undesignated net assets of the Center increased from US\$ 2,928 million at the end of 2018 to US\$ 3,326 million at the end of 2019.

Other indicators of financial health

The short-term solvency (liquidity) indicator level of the Center was improved to 96 days, up from 90 days as indicated for 2018, and the long-term financial stability ratio was similarly improved to 73 days up from 62 days as indicated for 2018. The audited indirect cost rate for AfricaRice decreased to 14.3% during the year, from 16.9% in 2018. The current ratio reduced from 1.38 in 2018 to 1.33 in 2019, which is within the CGIAR recommended level (greater than 1.0).

Summary Financials (expressed in thousands of US\$)

	2019	2018
Income statement		
Revenues	17,005	17,481
Operating surplus/(deficit)	121	304
Surplus/(deficit) for the year	83	158
Balance sheet		
Fixed assets (NBV)	3,164	3,424
Working capital	4,891	4,182
Non-current liabilities	2,202	2,349
Net assets		
Undesignated	3,326	2,928
Designated	2,014	2,328

Finance

Statements of activity (expressed in thousands of US\$)

	Total 2019	Total 2018
Revenue and gains		
Grant revenue		
Windows 1 and 2	4,177	4,222
Window 3	4,573	2,560
Bilateral	7,676	9,860
Total grant revenue	16,427	16,642
Other revenue and gains	578	839
Total revenue and gains	17,005	17,481
Expenses and losses		
Research expenses	11,756	13,339
CGIAR collaboration expenses	–	–
Non-CGIAR collaboration expenses	3,018	1,355
General and administration expenses	2,110	2,483
Other expenses and losses	–	–
Total expenses and losses	16,884	17,177
Operating surplus/(deficit)	121	304
Gain/loss on sale of assets	33	4
Restructuring cost/others	–	–
Financial income	–	15
Financial expenses	(72)	(166)
Surplus (Deficit) for the year	83	158

List of donors

AfricaRice sincerely thanks all the donors who have generously contributed to its success:

- AfricaRice Member States
- African Development Bank (AfDB)
- Belgium
- Bill & Melinda Gates Foundation
- Biotechnology and Biological Sciences Research Council (BBSRC)
- CGIAR Platform for Big Data in Agriculture
- CGIAR Research Program on Agriculture for Nutrition and Health (A4NH)
- CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)
- CGIAR Research Program on Policies, Institutions, and Markets (PIM)
- CGIAR Research Program on Rice Agri-food Systems (RICE)
- Côte d'Ivoire
- Cranfield University, UK
- Crop Trust
- European Union (EU)
- Food and Agriculture Organization of the United Nations (FAO)
- The Gambia
- German Corporation for International Cooperation (GIZ) GmbH
- German Federal Ministry of Economic Cooperation and Development (BMZ)
- International Fund for Agricultural Development (IFAD)
- Japan (MAFF, MOF, MOFA)
- Japan International Cooperation Agency (JICA)
- Japan International Research Center for Agricultural Sciences (JIRCAS)
- Liberia
- London School of Hygiene & Tropical Medicine (LSHTM)
- Madagascar
- Nigeria
- OCP Africa
- Rural Development Administration (RDA), South Korea
- Syngenta Foundation for Sustainable Agriculture (SFSA)
- Technical Centre for Agricultural and Rural Cooperation ACP–EU (CTA)
- United States Agency for International Development (USAID)
- West African Economic and Monetary Union (UEMOA)

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* Joined in 2019

‡ Left in 2019



Training 2019

AfricaRice training program (courses)



70 Training courses run in 2019



26 Locations



in **12** countries



5,813 Total trainees

... of whom



1,416 Female



4,397 Male

Postgraduate trainees



18 Total female postgrads



38 Total male postgrads



29 PhD students

... of whom



9 Female



20 Male



27 MSc students

... of whom





9 Female



18 Male

AfricaRice publications 2019


 **29** Articles in Thomson Reuters–list journals

 **3** Articles in other peer-reviewed journals

 **3** Book chapters

 **114** Scientific presentations in major meetings

 **18** Brochures

 **5** Others / reports

 **87** Videos
... in **2** languages

Selected titles in Science Citation Index (SCI) and Science Citation Index Expanded (SCIE) journals

Addison M, **Mujawariya G** and Bam R. 2019. Gender considerations in development and utilisation of technological innovations: Evidence from Ghana. *Development in Practice*, 30(1): 15–26. DOI: 10.1080/09614524.2019.1632263.

De Bauw P, Vandamme E, **Senthilkumar K**, **Lupembe A**, Smolders E and Merckx R. 2019. Combining phosphorus placement and water saving technologies enhances rice production in phosphorus-deficient lowlands. *Field Crops Research*, 236: 177–189. DOI: 10.1016/j.fcr.2019.03.021.

De Bauw P, **Vandamme E**, **Lupembe A**, **Mwakasege L**, **Senthilkumar K**, **Dramé KN** and Merckx R. 2019. Anatomical root responses of rice to combined phosphorus and water stress – relations to tolerance and breeding opportunities. *Functional Plant Biology*, 46: 1009–1022. DOI: 10.1071/FP19002.

Devkota KP, Pasuquin E, Elmido-Mabilangan, A, Dikitanan R, Singleton GR, Stuart AM, Duangporn V, Vidiyangkura L, Pustika AB, Listyowati C, Keerthisena RSK, Thi Kieu N, Malabayabas AJ, Hu R, Pan J and Beebout SJ. 2019. Economic and environmental indicators of sustainable rice cultivation: A comparison across intensive irrigated rice cropping systems in six Asian countries. *Ecological Indicators*, 105: 199–214. DOI: 10.1016/j.ecolind.2019.05.029.

Djaman K, Mel V, Boye A, Diop L, **Manneh B**, El-Namaky R, Koudahe K and **Futakuchi K**. 2019. Rice genotype and fertilizer management for improving rice productivity under saline soil conditions. *Paddy and Water Environment*, 18: 43–57. DOI: 10.1007/s10333-019-00763-w.

Huat J, Fusillier JL, **Dossou-Yovo E**, Lidon B, Kouyaté AM, **Touré A**, Simpara MB and Hamadoun A. 2019. Benefits and limits of inland valley development to enhance agricultural growth: A farmers' perception approach in southern Mali. *Environment, Development and Sustainability*. DOI: 10.1007/s10668-019-00466-6.

Johnson JM, Sila A, **Senthilkumar K**, Vandamme E, Shepherd KD and **Saito K**. 2019. Near-infrared, mid-infrared or combined diffuse reflectance spectroscopy for assessing soil fertility in rice fields in sub-Saharan Africa. *Geoderma*, 354: 113840. DOI: 10.1016/j.geoderma.2019.06.043.

Johnson JM, Rodenburg J, Tanaka, A. **Senthilkumar K**, **Ahouanton K**, **Dieng I**, Akakpo C, Segda Z, Yameogo LP, Gbakatchetche H, Bam RK, Bakare OS, Gasore ER, Ablede KA and **Saito K**. 2019. Farmers' perception of mechanical weeders for rice cultivation in sub-Saharan Africa. *Experimental Agriculture*, 55(1): 117–131. DOI: 10.1017/S001447971700059X.

Kwesiga J, Grotelüschen K, Neuhoff D, **Senthilkumar K**, Döring TF and Becker M. 2019. Site and management effects on grain yield and yield variability of rainfed lowland rice in the Kilombero floodplain in Tanzania. *Agronomy*, 9(10): 632. DOI: 10.3390/agronomy9100632.

Ndjiondjop MN, Alachiotis N, Pavlidis P, **Goungoulou A**, **Kpeki SB**, **Zhao D** and Semagn K. 2019. Comparisons of molecular diversity indices, selective sweeps and population structure of African rice with its wild progenitor and Asian rice. *Theoretical and Applied Genetics*, 132(4): 1145–1158. DOI: 10.1007/s00122-018-3268-2.

Ndindeng SA, Wopereis M, **Sanyang S** and **Futakuchi K**. 2019. Evaluation of fan-assisted rice husk fuelled gasifier cookstoves for application in sub-Saharan Africa. *Renewable Energy*, 139: 924–935. DOI: 10.1016/j.renene.2019.02.132.

Noriega IL, Halewood M, Abberton M, Amri A, Angarawai II, Anglin N, Blümmel M, Bouman B, Campos H, Costich D, Ellis D, Gaur PM, Guarino L, Hanson J, Kommerell V, Kumar L, Lusty C, **Ndjiondjop MN**, Payne T, Peters M, Popova E, Prakash G, Sackville-Hamilton R, Tabo R, Upadhyaya H, Yazbek M and Wenzl P. 2019. CGIAR operations under the plant treaty framework. *Crop Science*, 59(3): 819–832. DOI: 10.2135/cropsci2018.08.0526.

Rodenburg J, **Johnson JM**, **Dieng I**, **Senthilkumar K**, Vandamme E, Akakpo C, Allarangaye MD, Baggie I, Bakare SO, Bam RK, Bassoro I, Abera BB, Cisse M, Dogbe W, Gbakatchetche H, Jaiteh F, Kajiru GJ, Kalisa A, Kamissoko N, Sékou K, **Kokou A**, Mapiemfu-Lamare D, Lunze FM, Mghase J, Maïga IM, Nanfumba D, Niang A, Rabeson R, Segda Z, **Sillo FS**, Tanaka A and **Saito K**. 2019. Status quo of chemical weed control in rice in sub-Saharan Africa. *Food Security*, 11(1): 69–92. DOI: 10.1007/s12571-018-0878-0.

Saito K, Vandamme E, **Johnson JM**, **Tanaka A**, **Senthilkumar K**, **Dieng I**, Akakpo C, Segda Z, Bassoro I, Lamare, D, Gbakatchetche H, Bayuh BA, Jaiteh F, Bam RK, Dogbe W, Sékou K, Rabeson, R, Kamissoko N, Mossi IM, Tarfa BD, Bakare OS, Kalisa A, Baggie I, Kajiru GJ, Ablede K, Nanfumba D and Wopereis MCS. 2019. Yield-limiting macronutrients for rice in sub-Saharan Africa. *Geoderma*, 338: 546–554. DOI: 10.1016/j.geoderma.2018.11.036.

Saito K, **Toure A**, **Arouna A**, Fiamohe R, Silue D, Manful J, **Bèye A** and Efiusue AA. 2019. Multidisciplinary assessment of agricultural innovation and its impact: A case study of lowland rice variety WITA 9 in Côte d'Ivoire. *Plant Production Science*, 22 (4): 428–442. DOI: 10.1080/1343943X.2019.1667834.

Tang E N, **Ndindeng SA**, Bigoga J, **Traore K**, **Silue D**, **Futakuchi K**. 2019. Mycotoxin concentrations in rice from three climatic locations in Africa as affected by grain quality, production site, and storage duration. *Food Science and Nutrition*, 7(4): 1274–1287. DOI: 10.1002/fsn3.959.

Tsujimoto Y, Rakotoson T, Tanaka A and **Saito K**. 2019 Challenges and opportunities for improving N use efficiency for rice production in sub-Saharan Africa. *Plant Production Science*, 22(4): 413–427. DOI: 10.1080/1343943X.2019.1617638.

Wambugu PW, **Ndjiondjop MN** and Henry R. 2019. Advances in molecular genetics and genomics of African rice (*Oryza glaberrima* Steud). *Plants*, 8(10): 376. DOI: 10.3390/plants8100376.

Zossou E, **Arouna A**, Diagne A and Agbo-Noameshie RA. 2019. Learning agriculture in rural areas: The drivers of knowledge acquisition and farming practices by rice farmers in West Africa. *The Journal of Agricultural Education and Extension*, 26(3): 291–306. DOI: 10.1080/1389224X.2019.1702066.

Abbreviations

ACP	African, Caribbean and Pacific group of states
ADRAO	Association pour le développement de la riziculture en Afrique de l'Ouest (former French name of AfricaRice)
AfricaRice	Africa Rice Center
AKRiL	Africa–Korea Rice Breeding Lab
ANCAR	Agence nationale de conseil agricole et rural (Senegal)
ARICA	Advanced Rice for Africa (varieties)
ASI	ADRAO–SAED–ISRA thresher–cleaner
AZ	Arizona
BP	Boîte Postal (post office box)
CARD	Coalition for African Rice Development
CARI	Central Agricultural Research Institute (Liberia)
COVID-19	Coronavirus disease 2019
CRP	CGIAR Research Program
CTA	Technical Centre for Agricultural and Rural Co-operation
DOI	Digital Object Identifier
ECOWAS	Economic Community of West African States
FOFIFA	Centre national de recherche appliquée au développement rural (Madagascar)
ha	hectare
ICT	information and communications technology
IFAD	International Fund for Agricultural Development
IITA	International Institute of Tropical Agriculture
IP	innovation platform
ISBN	International Standard Book Number
ISRA	Institut sénégalais de recherches agricoles (Senegal)
KAFACI	Korea–Africa Food and Agriculture Cooperation Initiative
MAFF	Ministry of Agriculture, Forestry and Fisheries (Japan)
MOF	Ministry of Finance (Japan)
MOFA	Ministry of Foreign Affairs of Japan
Mt	million tonnes
NAFASO	Neema Agricole du Faso SA
NBV	net book value
NCRI	National Cereals Research Institute (Nigeria)
NERICA	New Rice for Africa (family of interspecific rice varieties for uplands)
NERICA-L	New Rice for Africa (family of interspecific rice varieties for lowlands)
NGN	Nigerian naira
PEJERIZ	Promoting Youth Entrepreneurship and Job Creation in West Africa's Rice Value Chain
PhD	Doctor of Philosophy (doctoral degree)
PMB	Personal Mail Bag

PO	Post Office
pp.	pages
PR	perennial rice
PRUN SAR	Putting Research Into Use for Nutrition, Sustainable Agriculture and Resilience
QTL	quantitative trait locus
RAB	Rwanda Agriculture Board
RICE	CGIAR Research Program on Rice Agri-food Systems
riceTDI	Rice technology delivery infrastructure
RYMV	Rice yellow mottle virus
SAED	Société d'aménagement et d'exploitation des terres du delta et des vallées du fleuve Sénégal et de la Falémé (Senegal)
SMEs	small and medium-sized enterprises
SNP	single-nucleotide polymorphism
t	tonne(s)
TAAT	Technologies for African Agricultural Transformation (project)
UK	United Kingdom of Great Britain and Northern Ireland
US	United States
USA	United States of America

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The Centers

AfricaRice	Africa Rice Center (Abidjan, Côte d'Ivoire)
Bioversity	Bioversity International (Rome, Italy)
CIAT	International Center for Tropical Agriculture (Cali, Colombia)
CIFOR	Center for International Forestry Research (Bogor, Indonesia)
CIMMYT	International Maize and Wheat Improvement Center (Mexico, DF, Mexico)
CIP	International Potato Center (Lima, Peru)
ICARDA	International Center for Agricultural Research in the Dry Areas (Beirut, Lebanon)
ICRAF	World Agroforestry (Nairobi, Kenya)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics (Patancheru, India)
IFPRI	International Food Policy Research Institute (Washington, DC, USA)
IITA	International Institute of Tropical Agriculture (Ibadan, Nigeria)
ILRI	International Livestock Research Institute (Nairobi, Kenya)
IRRI	International Rice Research Institute (Los Baños, Philippines)
IWMI	International Water Management Institute (Colombo, Sri Lanka)
WorldFish	WorldFish Center (Penang, Malaysia)



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