



AfricaRice

Sustainable rice production in the face of climate emergency

Africa Rice Center (AfricaRice) – Annual Report 2018

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Cover: From time to time, seeds stored in the gene bank are germinated and grown, for characterization or to regenerate seed.

About Africa Rice Center (AfricaRice)

AfricaRice is a leading pan-African research organization working to contribute to poverty alleviation and food security in Africa through research, development and partnership activities. 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 27 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, 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 also in AfricaRice research stations in Liberia, Madagascar, Nigeria, and Senegal. For more information, visit www.AfricaRice.org

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AfricaRice

Message from the Board Chair and Director General

Climate change is now very high up on the political and social agenda and its impacts are increasingly considered as a “crisis” or “emergency.” Africa is one of the regions of the world that is the hardest hit by climate variations and the resulting increasing incidence of droughts and floods. Agriculture is taking the brunt of the increasingly hostile weather patterns and their effect, across the continent; and the rice subsector is no exception.

Over the past decade of implementing our Strategic Plan (2011–2020), AfricaRice scientists and their colleagues in partner institutions have paid considerable attention to climate change and its effects on the rice sector in

Africa. Research work has focused on the development of climate-smart varieties, models, and practices to overcome the direct effects of climate change, such as increasing temperatures and their effects including droughts and floods – in order to boost rice productivity and ensure sustainable rice production.

Research and innovation highlights

Inland valleys, which are considered the future ‘rice basket’ of the continent, have been the major agro-ecosystems where we have focused our work in 2018 as we increase our efforts to unleash the potential of these fragile agro-ecosystems that are threatened by



Chair of the Board of Trustees, Prof. Em. Dr Ir Eric Tollens (right), with Director General, Dr Harold Roy-Macauley

increased episodes of flash-flooding due to climate change. Our scientists and their partners have developed tools such as climate models that predict the likelihood of flash-flooding in valley bottoms where rice is often the crop of choice. Genetic resources development work has resulted in the creation, using the *Sub1* gene, of rice varieties tolerant to submergence for up to a fortnight, which can be tested in inland valleys (page 6). Staying with inland valleys, our work on Smart-valleys has reached the point of determining impact at the original pilot sites (page 9).

Drought prediction models have been developed to help farmers manage their rice crops (page 10) and valuable heat-tolerance genes from African cultivated rice (*Oryza glaberrima*) have been unlocked and can be used to develop heat-tolerant varieties (page 11).

A key partnership established with the Sustainable Rice Platform initiative, co-convened by the United Nations Environment Programme and the International Rice Research Institute (IRRI), has allowed access to methodologies that facilitate the measurement of farm sustainability, a pathway to achieving sustainable rice cultivation across the continent (page 12).

Efforts in cross-disciplinary research collaboration, in particular connections between gender and agronomy research, have resulted in the development of the ‘fertiseeder’, a small-scale machine that deposits fertilizer along with seed in rows. This machine is appreciated as a time-saving technology by men and women rice farmers alike (page 13).

Efforts to upgrade the rice value chain are being pursued with the improvement of the successful GEM parboiling processing equipment to work with processed rice husk as a fuel. This is saving time and money, producing less pollution (smoke and soot) and generating a ‘free’ fertilizer into the bargain (page 14).

Next, we look at rice farming as a business, which presents a strong opportunity for job creation for youth (page 15), and a new NGO that is supporting agricultural business services (page 16).

Finally, we examine a critical partnership with the Food and Agriculture Organization of the United Nations (FAO) for capacity strengthening along the value chain (page 17), before reviewing no less than seven new partnerships established in 2018 (page 18).

New strategic projects

The year 2018 saw the launch of important projects that provide opportunities for disseminating scalable technologies developed by AfricaRice. These include ‘Capitalizing the inland valley potential for food and nutrition security for smallholder farmers in West Africa’ (CIPA), which was launched in June to optimize the use of inland valleys in Côte d’Ivoire and Ghana. This project is expected to benefit about 2,000 rural households (i.e. about 10,000 individuals). The beneficiaries (at least 40% women and 25% youth) consist of smallholder farmers, agro-pastoralists and other users of inland-valley resources, traders, processors and rural entrepreneurs.

CIPA will take the tried-and-tested multistakeholder innovation platform approach to boost food security and poverty alleviation, while conserving inland-valley biodiversity and enhancing climate resilience for the communities involved.

The project ‘Promoting youth entrepreneurship and job creation in West Africa’s rice value chain’ (PEJERIZ), which was launched in collaboration with the Technical Centre for Agricultural and Rural Co-operation (CTA) and the Syngenta Foundation for Sustainable Agriculture, demonstrates the Center’s growing commitment to job creation, especially for youth. The project is targeting 1000 new jobs, increased revenues for up to 2500 smallholders, and reaching a further 15,000 rural youths with entrepreneurship opportunities through information and communications technology (ICT) channels.

The Rice Value Chain Compact of the ‘Technologies for African agricultural transformation’ (TAAT) project was launched in September. Funded by the

African Development Bank (AfDB), it feeds into AfDB's Feed Africa initiative. The TAAT Rice Compact is being implemented in nine countries in its first year, with spillover to three more. TAAT was instrumental in the successful deployment of *Subl* varieties in Guinea and in scaling out the Mini-GEM rice parboiler.

AfricaRice is committed to working with all the partners to achieve the goals of the Coalition for African Rice Development (CARD), which entered its second phase in October. This new phase is aiming to double continental rice production (to an estimated 56 million tonnes) between 2019 and 2030 by adopting an approach called RICE (Resilience, Industrialization, Competitiveness, and Empowerment). Membership will be extended to a further nine countries: Angola, Burundi, Chad, Congo, Gabon, Guinea-Bissau, Malawi, Niger and Sudan.

Membership of the Association

During the 31st Council of Ministers (CoM) meeting of AfricaRice, which was held in Senegal in September, Mozambique was accepted by the CoM as the 27th member country of AfricaRice. Kenya's application for membership was also accepted for ratification by member countries, after which it will become the 28th member country.

Consolidating and reaching out

With focus on consolidating research capacity at the M'bé research station, the year saw more staff relocate to Bouaké/M'bé, so that there were 72 staff posted there by the end of 2018. Completion of the construction of the gene bank at the M'bé station saw the repatriation of the active (medium-term) rice genetic resources collection arriving from Cotonou in February and the base (long-term) collection from Ibadan in December (*see 'Securing the future through genetic resources', AfricaRice annual report 2015, page 9*).

The Continental Investment Plan for Accelerating Rice Self-Sufficiency in Africa (CIPRiSSA) report on 10 countries was published and widely distributed. Additional study carried out for the Gambia was completed and will be presented to AfDB. Evidence-based information resulting from CIPRiSSA studies are gradually being mainstreamed into programmatic activities. This approach will eventually be fully integrated into the structure of the AfricaRice Program Division and will be considered as an important element in the next strategic planning process.

Approaching a new strategic plan period

The current Strategic Plan runs to the end of 2020. The Board and management have started the process for developing the next plan with a 'stop and think strategy workshop', which was held during the AfricaRice Science Week in 2018, with support provided by SRI Executive.

Financial situation

The objective fixed for the first year of the 3-year financial recovery plan was reached, with the Center achieving a balanced budget by year-end, with a surplus of US\$ 158,000. The total revenue registered stood at \$ 17.48 million and fundraising continued to improve.

CGIAR System Organization

The Board Chair and Director General continue to be involved, either physically or virtually, in the various activities and meetings of the CGIAR System Organization. Key System initiatives in 2018 included the development of the 'Crops to end hunger' (CtEH) initiative; the CGIAR 3-year business plan; opportunities to access the Green Climate Fund; and a Road Map for 2030. The AfricaRice Director General was selected to represent the CGIAR System Organization on the Board of the Forum for Agricultural Research in Africa (FARA).

Enhanced relationship between AfricaRice and IRRI

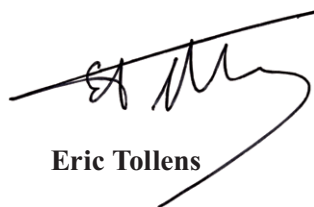
AfricaRice and the International Rice Research Institute (IRRI) embarked on developing a programmatic and institutional alliance framework to leverage their combined capabilities to efficiently and effectively contribute to reducing the widening gap between rice supply and demand in Africa. This will involve the development and implementation of a single coherent and impactful rice-based agri-food research-for-development program for Africa to address the emerging challenges of climate change and nutrition. This process is also aligned to the current

evolution of the CGIAR to a ‘One CGIAR’ for more viability and increased funding opportunities.

The end of the second decade of the 21st century is a critical period in human history. There are those who say that the environmental tipping point is likely to occur earlier and more rapidly than expected, and so climate action cannot wait. Meanwhile there are more mouths to feed and more of those are in urban centers. Sustainable increase of rice production through productivity enhancements, area expansion (into inland valleys) and maximizing (physical and monetary) returns from the whole rice value chain is more important than ever.



Harold Roy-Macauley



Eric Tollens

Learning to tolerate flooding, a major problem in inland valleys that's worsening as the climate changes

One feature of the global climate catastrophe as it is unfolding in the tropics is the irregularity of precipitation. In particular, while rainfall events are becoming fewer they are tending to be increasingly intense. This brings a greater risk of flooding, especially in areas with limited water-control infrastructure. One notable response to this has been the development of the Smart-valleys approach. Another is to develop flood/submergence-tolerant rice varieties.

History in brief

AfricaRice started breeding work with the flooding/submergence-tolerance gene *Sub1* in 2010 under the 'Stress tolerant rice for poor farmers in Africa and South Asia' (STRASA) project. Near-isogenic lines carrying the *Sub1* gene were developed using marker-assisted selection from the popular 'mega-varieties' WITA 4 and NERICA-L 19,¹ culminating in one of each being released in Nigeria in 2017, as FARO 66 and FARO 67, respectively.² These two varieties produce 6–29% higher yield under non-submergence conditions than their recurrent parents, but if submerged for a week or two, they can amazingly produce 10–80 times more yield than their recurrent parents under the same conditions. They also have shorter growth durations. Moreover, they retain their recurrent parental characteristics of good grain quality with medium-long slender grains and moderate iron-toxicity tolerance.

Getting the new varieties to those who need them

Although these varieties have been adopted in some rice areas in Nigeria, and their seeds were requested

by Liberia, Madagascar, Sierra Leone and Uganda, large-scale adoption is still a challenge.

The next step is to promote them first where the mega-varieties NERICA-L 19 and WITA 4 are already adopted and popular among lowland-rice farmers.

To prioritize target areas, AfricaRice is using the flood-risk assessment map developed in 2015–2016³ and alerting governments in the identified countries of the available *Sub1*-introgressed materials, especially in countries where WITA 4 and/or NERICA-L 19 have already been released. The varieties are also being disseminated via the Africa-wide Rice Breeding Task Force to countries where the parent varieties are not currently used. Interest in the varieties has already been expressed by national programs and/or farmers in Benin, The Gambia and Senegal.

There is a saying that 'every cloud has a silver lining': that may be stretching a point, but emergency seed provision has proved a useful route for delivering submergence-tolerant varieties to countries in crisis (*see* Box 'Sub1 to the rescue in Guinea').

Refining recommendations for coping with early-season flash-floods

Rice is typically transplanted into prepared inland-valley lowland fields, especially in West Africa, after it has grown in nurseries for about 21 days. However, early-season flash-flooding is an increasingly common occurrence in many inland valleys and is likely to occur as early as 1 month into the season, potentially hitting the transplanted plants before they have fully established. With the aim of refining

1. See 'Managing stresses on rice for the benefit of African farmers', *AfricaRice annual report 2015*, page 10.

2. See 'Breakthrough in lowland rice breeding targeting submergence tolerance', *AfricaRice annual report 2017*, pages 8–9.

3. See Zwart SJ and Hamady M. 2016. Finding flood-prone rice areas in West Africa. *Rice Today*, 2 March. <<http://ricetoday.irri.org/finding-flood-prone-rice-areas-in-west-africa/>>



Mature direct-seeded rice that experienced early-season flooding for 7 days: non-Sub1 variety WITA 9 (foreground) compared with Sub1 varieties of NERICA-L 19 and WITA 4 (background)



Transplanted rice that experienced early-season flooding for 7 days: non-Sub1 WITA 9 (foreground) compared with Sub1 mega-variety (background)

Sub1 to the rescue in Guinea

In the 2017 wet season, Guinea experienced heavy rainfall, resulting in flooding which caused failure of some rice crops, including those grown for seed, which in turn could have exacerbated social instability. Guinea is still recovering from the Ebola crisis and the social situation in the country is extremely fragile.

Demonstration plots of the *Sub1* varieties were established in Guinea in 2018 to accelerate variety dissemination. During that cropping season, heavy rainfall again afflicted some rice-growing areas in the country, with rice plants suffering 10 days of flooding. Farmers were particularly impressed as the *Sub1* varieties withstood the flooding and continued normal growth.

Abou Camara of Koba, who has been farming rice since 1998, received seed of the new climate-smart varieties NERICA-L 19-*Sub1* and WITA 4-*Sub1*. During a monitoring visit by AfricaRice and Institut de recherche agronomique de Guinée (IRAG) when the crop was mature, Camara indicated that he has been receiving rice seed from AfricaRice since 1998, including NERICA-L 19 in 2016. The NERICA-L 19 he received in 2016 does not have the flood-tolerance gene. However, he reported that the new NERICA-L 19-*Sub1* and WITA 4-*Sub1* were able to tolerate the 10 days of flooding during the vegetative stage, and they showed normal growth. “Both NERICA-L 19-*Sub1* and WITA 4-*Sub1* showed high promise of a very good harvest despite the flooding in my farm,” said Camara, “something I have never experienced in the past with the AfricaRice varieties. I am proud of this scientific achievement.”

Through the Japan Emergency Seed Project in collaboration with Technologies for African Agricultural Transformation (TAAT), AfricaRice produced 10 tonnes of foundation seed of four varieties – local mangrove landrace Mbapeya, popular mangrove variety ROK5, WITA 4-*Sub1* and NERICA-L 19-*Sub1*. From that foundation seed, at least 400 tonnes of certified seed is expected to be produced by farmer seed producers, with technical support from IRAG in 2019. The expected certified seed, which will cover 8000 ha, should reach 32,000 smallholder rice farmers and benefit an estimated 160,000 individuals.

Feature

recommendations for flash-flood-prone areas for choice of variety and crop-establishment method, AfricaRice has initiated experiments to determine the effect of crop-establishment method combined with submergence-tolerant *Sub1* varieties on tolerance and resilience to early-season flash-flooding.

Consequently, experiments were set up at the AfricaRice main research station at M'bé, Côte d'Ivoire. Pre-germinated rice seed was 'wet direct-seeded': broadcast or sown in lines in puddled soil. This was compared with typical transplanting. Fields were flooded for 7 days to a depth of 10 cm above the top of the plants, starting 35 days after sowing or 15 days after transplanting.

Under direct-seeded conditions, flooding resulted in the loss of 15% of submergence-susceptible WITA 9 plants, but no loss of FARO 66 and FARO 67 plants. Transplanted rice experienced greater plant losses (49% for WITA 9, 21% for FARO 66 and 29% for FARO 67). This indicated that direct-seeding is better for flood tolerance than transplanting. The *Sub1* varieties yielded 18% more grain than WITA 9 under direct-seeding, and 69% more when transplanted –

demonstrating the superiority of the *Sub1* varieties under early-season flash-flooding.

Thus, ideally farmers should adopt the new submergence-tolerant varieties. However, where these are not yet available, switching to direct-seeding should significantly decrease the impact of early-season flash-flooding on final yield of susceptible varieties such as WITA 9, as long as the crop is established 15–30 days before the flooding occurs.

Since its introduction to the AfricaRice breeding program, the submergence-tolerance *Sub1* gene has proved its worth. With increasing likelihood of flash-flooding of inland-valley lowlands, its value in the drive to make rice cultivation sustainable in the face of the climate emergency is high indeed. AfricaRice is continuing to promote the adoption of the *Sub1* varieties and to verify recommendations for crop-establishment in inland valleys.

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Research and innovation highlights

Impact of the Smart-valleys approach in West Africa

The Smart-valleys approach was introduced in Benin and Togo in 2010 to improve water control and soil fertility management, and increase rice productivity in the context of climate change. Smart-valleys is a participatory, low-cost and easy-to-replicate water and land management system for rice production.¹ Outscaling began in the two countries in 2012.

By 2014, about 1486 inland-valley farmers (818 women) in the project areas had adopted Smart-valleys, building and maintaining their own drainage canals, irrigation infrastructure (where enough water was available), and bunded and leveled rice fields on 474 ha (*see image*). In 2016, AfricaRice assessed the adoption, diffusion and the impact of the approach in Benin and Togo. Data were collected from 590 rice-farming households.



Map showing the tracking of Smart-valleys in Zoungo, Benin – non-selection of road and housing indicates the validity of the method

Five factors drive adoption: (1) availability of inland-valley land; (2) total land area available; (3) land tenure security; (4) the market price of paddy; and (5) membership of a farmers' association. While the first four were positively correlated with adoption, the fifth, surprisingly, showed a reverse relationship: members of a farmers' association were less likely to adopt Smart-valleys. The lead researcher suggests that this may be the result of 'elite capture', with trained lead farmers not passing on their knowledge to others in their associations.

On average, adoption enabled producers to increase yields by 0.92 tonnes per hectare (0.88 t/ha for women), net income by US\$ 267/ha (\$198/ha for women). The food consumption score indicates that adoption helps women to increase food security more compared to men.²

Widescale diffusion of and direct training of individual farmers on the approach would likely help smallholder rice farmers to adapt to the climate change and improve their livelihoods. To ensure sustainability and widescale adoption of Smart-valleys, training on site selection, construction of irrigation canals and tiller use will need to be promoted. Training on the use of inputs and marketing, and access to input and output markets will help achieve greater impact.

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1. See 'Out-scaling Smart-valleys to boost rice productivity', *AfricaRice annual report 2016*, pages 15–16.
2. See 'For more details and more results, see Arouna A and Akpa KAA. 2019. Water management technology for adaptation to climate change in rice production: Evidence of Smart-valley approach in West Africa. In: Sarkar A, Sensarma S and van Loon G eds. *Sustainable solutions for food security*. Springer, Cham. doi:10.1007/978-3-319-77878-5_11.

Research and innovation highlights

Can we predict drought in inland-valley rice-based production systems?

Rainfall and water availability are vital to the rainfed rice-based production systems that make up an estimated 74% of sub-Saharan Africa’s rice area.¹ Under the growing climate crisis, alongside flooding, drought is another increasing cause of low agricultural profitability and crop production vulnerability. However, most African countries have paid little to no consideration to readiness for drought.

AfricaRice collected primary biophysical and socio-economic data (including via farmer surveys) and secondary data on soil characteristics and water demand (via remote sensing) to evaluate the predictors of drought in inland-valley rice-based production systems and the factors affecting farmers’ mitigation measures. The study was carried out in Burkina Faso, Mali and Nigeria.

Significant drying trends have occurred at latitudes below 11°30', while significant wetting trends were discerned at latitudes above 11°30'. Drought was more frequent and of longest duration in the Nigerian states of Niger and Kaduna and in western Burkina Faso during the period 1995–2014.

Among 21 candidate drought-predictors, average annual ‘standardized precipitation evapotranspiration

index’ (SPEI; a drought index that includes a comprehensive water balance)² and duration of groundwater availability were best correlated with drought occurrence in inland-valley rice-based systems (Figure 1). Meanwhile, land ownership and gender affected rice farmers’ use of any mitigation measure against drought (women farmers are more likely to adopt mitigation measures than men).

It was concluded that future drought studies in inland valleys should include climatic water balance and groundwater data, while securing property rights and focusing on women’s associations would improve farmers’ resilience and promote drought-mitigation measures.

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1. Calculated from data presented in: Diagne A, Amovin-Assagba E, Futakuchi K and Wopereis MCS. 2013. Estimation of cultivated area, number of farming households and yield for major rice-growing environments in Africa. In: Wopereis MCS, Johnson D, Ahmadi N, Tollens E and Jalloh A eds. *Realizing Africa’s rice promise*. CAB International, Wallingford, UK.
2. Vicente-Serrano SM, Beguería S and López-Moreno JI. 2010. A multiscalar drought index sensitive to global warming: The standardized precipitation evapotranspiration index. *Journal of Climate*, 23(7): 1696–1718. doi:10.1175/2009JCLI2909.1.

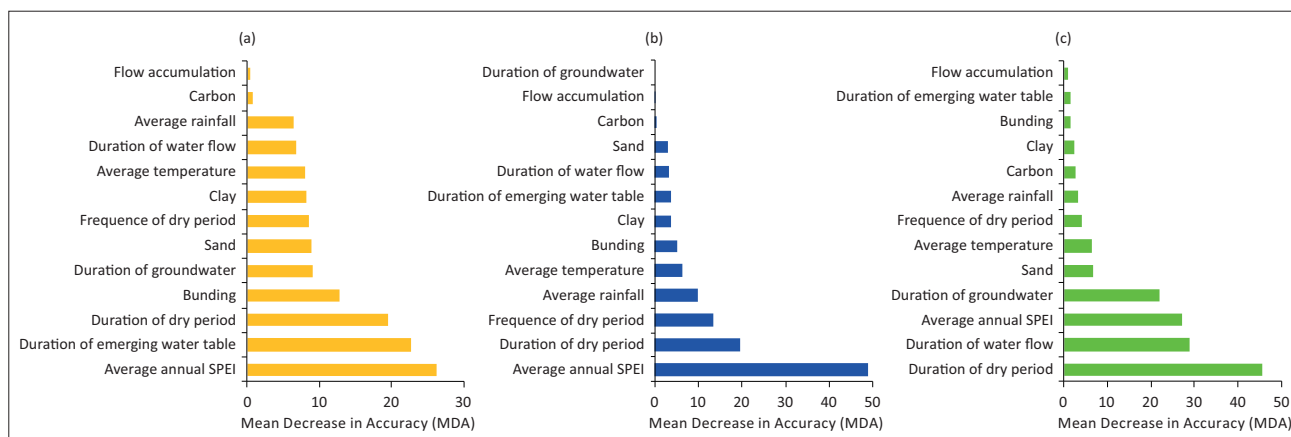


Figure 1: Ranking of drought predictors by contribution for (a) Burkina Faso, (b) Mali and (c) Nigeria

Unlocking the genetic potential of *Oryza glaberrima* for heat tolerance

With global heating, high temperature is an increasingly key abiotic stress especially in the Sahel, which has the highest rice yield potential in Africa. *Oryza glaberrima* is considered heat tolerant during the reproductive stage as it flowers early in the morning and thereby escapes heat stress (rice plants are highly sensitive to heat stress at flowering). However, the diversity within *O. glaberrima* for ‘early morning flowering’ (EMF) needed to be well characterized to identify superior donors that could then be used in breeding for heat tolerance.

With this goal, AfricaRice characterized its entire collection of *O. glaberrima* germplasm (2093 accessions) along with a number of *O. sativa* genotypes of African origin over two seasons (one wet, one dry) in 2016/17 for EMF. The data are available on the AfricaRice gene bank website, the Genesys Catalog¹ and the Germplasm Resource Information Network (GRIN-Global project),² including for 434 accessions that first flowered before 6:30 a.m.

The EMF of those 434 accessions was validated in trials in 2018, from which 70 accessions were further evaluated for early peak spikelet opening time (EPSOT), whereby more than 80% of spikelets flower before 9 a.m.

A set of 15 *O. glaberrima* accessions was identified as not only exhibiting EMF across (two) years, (wet and dry) seasons and (two) locations, but also exhibiting EPSOT (one *O. sativa* variety, WAB638-1, that exhibits EMF does not exhibit EPSOT).

These are the first rice genotypes that have been identified with both EMF and EPSOT, and constitute promising donors for use in rice breeding for heat tolerance.



Left: Anthesis (flower fully open and functional) of *Oryza glaberrima* with early morning flowering and early peak spikelet opening time (EPSOT). Right: Early morning flowering spikes marked for individual harvest of seed (rain-out shelter, Cotonou research station, wet season 2016)

Full details of these genotypes will be uploaded to the public GRIN-Global database once they have been published in a peer-reviewed journal. At that stage, these early flowering materials will be available to rice breeders and genetic resources specialists globally for genetic study and developing heat-tolerant rice varieties.

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1. <<https://catalog.genesys-pgr.org/datasets/202ca6b1-0589-4819-9d09-ae14a416081b>>
2. <www.grin-global.org>

Research and innovation highlights

Working towards sustainable rice cultivation

AfricaRice is increasingly moving beyond its traditional productivity/production focus to embrace sustainability. In late 2017, AfricaRice was asked by the Competitive African Rice Initiative (CARI) to work with the Sustainable Rice Platform (SRP, *see* Box ‘Sustainable Rice Platform’) to identify sustainability levels of, constraints to and opportunities for rice production in Africa. Partnering with the German Federal Ministry for Economic Cooperation and Development and Deutsche Gesellschaft für Internationale Zusammenarbeit (BMZ–GIZ) global program Green Innovation Centres for the Agriculture and Food Sector (GIAE), AfricaRice and CARI assessed the rice cultivation of farmers in Burkina Faso, Ghana, Nigeria and Tanzania. AfricaRice also conducted the assessment in Senegal. In 2018, the Center joined SRP, and agronomist Kazuki Saito was invited to join its Working Group on Farmer Support, Performance Measurement, and Assurance, helping revise the SRP Standard and Performance Indicators.

The assessment in Senegal showed that farmers achieve low scores on the SRP Standard. “We identified key intervention areas for enhancing social, economic and environmental sustainability,” says Saito. “They

are being included in the training modules. For example, we found a need for training in integrated crop production – crop calendar, record-keeping, land preparation, water management and pesticide management.” Use of the modules in training farmers should increase their knowledge of sustainable rice cultivation. Furthermore, one of the SRP performance indicators, nitrogen-use efficiency, was particularly low and a suitable target for improvement (e.g. through use of RiceAdvice).¹

“Once farmers cultivate rice after the training and harvest their rice, we will use SRP Standard and Performance Indicators for assessing farmers’ improvements in cultivation practices and production,” says Saito. This cycle – assessment, training, implementation, re-assessment, and so on – will be especially useful in the context of contractual farming and outgrower schemes, to provide incentive for productivity and sustainability improvements.

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1. See <www.riceadvice.info/en/>

Sustainable Rice Platform (SRP)

The Sustainable Rice Platform (SRP) is a multi-stakeholder alliance led by UN Environment, the International Rice Research Institute, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and over 100 institutional members in the public and private sectors, as well as international organizations, NGOs and the international research community. SRP promotes resource efficiency and sustainability, both on farm and at landscape and policy levels.

SRP developed the world’s first rice sustainability standard and impact indicators. Its goal is to harness innovation to encourage 1 million rice smallholders to adopt climate-smart, sustainable best practices, while enhancing smallholder livelihoods and protecting the environment.

<www.sustainablerice.org>



Cross-discipline collaboration delivers ‘fertiseeder’ for men and women farmers in Madagascar

In a ‘first’ for AfricaRice, agronomists and gender specialists have collaborated in identifying and adapting small-scale labor-saving technology for use by smallholders on their rice fields.

Field trials of four seeders conducted at four sites in Madagascar with 222 famers (132 men and 90 women) produced a clear ‘winner’ in the form of the ‘fertiseeder’. This mechanical seeder combines four actions into one: drilling a hole, adding the rice seed, adding fertilizer and covering the hole. Sixty-four percent of the men and 44% of the women preferred the fertiseeder over another three seeders without the fertilizer application functionality, well clear of the second-favorites which gained the support of 24% of the women and just 14% of the men.

The men were happy to point out the advantages of seeders over hand-sowing in terms of reduced labor and cost (26 responses), efficiency (17) and precision (9). Female farmers also appreciated its efficiency with regard to time saving and large area coverage; one woman farmer commented: “We prefer to push this seeder rather than bending to sow manually, ... you have no idea how hard it is to bend for a whole

day.” The time-saving element goes beyond the sowing itself, as rice sown evenly spaced in rows is amenable to simpler mechanical weeding.

“The advantages of this new machine are clear,” says extension agronomist Senthilkumar Kalimuthu. “It creates uniform holes, adds the correct number of seeds and the right dose of fertilizer. It may provoke a change in labor patterns, with men potentially taking over sowing and freeing women’s labor to do other [household, farm or off-farm] tasks. Hence, overall all the farmers are keen.”

A major complaint of the women farmers was that the fertiseeder is hard to push or is heavy. With this in mind and despite the fact that the prototype tested weighed less than 10 kg, AfricaRice is working to produce an improved, lighter version.

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Demonstration of the seeders, Antsirabe, November 2018



Two seeders and fertiseeder (far right) in action, Mahitsy, October 2018

Research and innovation highlights

Fueling the GEM with rice husk: Good for the household economy, the environment and health

With the adoption of the ‘Big-GEM’ parboiling system by innovation platforms in several rice sector development hubs, rice parboilers experienced economies of scale, cleaner and healthier practices, reduced fuelwood consumption and a better product, providing better returns.¹

In 2016, AfricaRice imported household gasifier stoves from Southeast Asia, increased their size, changed their air-supply system and coupled to the GEM to develop the ‘Mini-GEM’ parboiler, which was pilot-tested in Benin and Côte d’Ivoire.

Despite being a vast improvement on traditional methods of parboiling, the fuelwood energy supply of the GEM presents problems. First is the rising cost of fuelwood as the forests and countryside become denuded of dry wood. Second is the production of smoke and soot – blackened pots take up valuable labor for cleaning. One answer to these is a by-product of rice milling: husk. Rice husk can be burned in fan-assisted gasifier stoves to generate heat.

In the pilot-tests, women parboilers simply collected the husk from the miller along with their milled rice, effectively replacing increasingly costly wood with free fuel. At one site in Côte d’Ivoire, the innovation platform parboilers saved almost US\$ 4000 in wood costs over a 14-month period while parboiling 136 tonnes of paddy. The husk also produces near-zero smoke and soot, thereby alleviating air-pollution and pot-blackening.

An additional environmental bonus is that heat production from rice husk can produce biochar, an effective fertilizer. Women parboilers were trained to prevent



Women parboilers in Gagnoa, Côte d’Ivoire, using rice-husk stove for parboiling

the burning husk from turning to ash and rather generate biochar as a by-product.

A recent workshop brought together nine manufacturing companies from six countries to standardize rice technologies, including the Mini-GEM (both wood-fueled and rice-husk-fueled versions). The ‘Technologies for African agricultural transformation’ (TAAT) project is contracting these manufacturers to build and install Mini-GEMs in Benin, Cameroon, Côte d’Ivoire, Mali, Ghana, Nigeria and Senegal.

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1. See ‘Improving the quality of parboiled rice’, *AfricaRice annual report 2016*, pages 19–20.

Youth entrepreneurship and job creation in West Africa's rice value chain

The growing rice value chain offers huge job opportunities for rural youths. To capitalize on this potential, the Technical Centre for Agricultural and Rural Cooperation (CTA), AfricaRice and the Syngenta Foundation for Sustainable Agriculture launched the 2-year project 'Promoting youth entrepreneurship and job creation in West Africa's rice value chain' (PEJERIZ) in March 2018.

The project is being implemented in Mali and Senegal to mobilize and build the capacity of youth through training, and to develop youths' entrepreneurial skills and market linkages. AfricaRice delivered technical training in quality rice production, processing and service provision; and trained youths with an agriculture background in entrepreneurship and personal development. Thus, 310 young people (30% female) were mobilized and sensitized on business opportunities in the rice value chain. More than 8000 members of interested youth groups will indirectly benefit from this capacity-building: 5326 in Senegal and 3342 in Mali. In addition, 215 individual youth or youth-group representatives (28% female) have already been trained in entrepreneurship, integrated



Training session at the AfricaRice training center in Senegal

crop management of paddy and seed, processing, marketing and service delivery.

Through a competitive process, 80 of these trainees – those with the most promising ideas – received support to finalize their business plans and seed money in the form of a grant from the project (20%) and an agreement for co-financing loans from the national agricultural banks (80%). AfricaRice is collaborating with 'incubation centers' to provide awardees with mentoring and coaching. Innovative services provided by the new youth-led micro, small and medium-sized enterprises are expected to significantly improve the performance and competitiveness of local rice businesses, thereby increasing smallholder rice farmers' and entrepreneurs' incomes.

Meanwhile, after successful (pre-project) pilot-testing in the two countries, Syngenta Foundation is establishing 10 new Centers for Mechanized Services (CEMAs), which will provide a variety of mechanized services to farmers and other value-chain actors, from land preparation, through harvesting, threshing and storage, to processing and marketing. The CEMAs are employing youth as service providers for both mechanized services and associated digital services (e.g. RiceAdvice).¹ While CTA is responsible for project-based information and communications technology training of selected youth, the CEMAs have already recruited and trained 45 RiceAdvice service agents.

Overall, the project is aiming to create 1000 jobs in the two countries.

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1. See <www.riceadvice.info/en/>

African Innovation Services launched to maintain momentum for agricultural business services in Benin

In 2018, key national partners from the ‘Strengthening the agricultural innovation system in Benin’ project (under the umbrella of the German Federal Ministry for Economic Cooperation and Development and Deutsche Gesellschaft für Internationale Zusammenarbeit (BMZ–GIZ) global program Green Innovation Centres for the Agriculture and Food Sector (GIAE) created the NGO African Innovation Services (AFRIS) to continue the project work on a sustainable business basis.

The project introduced a new business model (Rural Universe Network, RUN) and established a network of partners and experts, and another of agricultural service providers, along with an online collaboration platform.¹ The 3-year project worked in 17 of the country’s 77 municipalities (*communes*), creating jobs for 440 service providers (72 of them women), reaching over 8000 smallholder farmers and over 50,000 individuals. The innovation services on offer were demonstrated to increase rice productivity by 72% compared with local practices.

The main result of the project is the operational framework for innovation and youth employment at large scale. It was developed and tested in collaboration with national and local stakeholders. The framework strengthens systematic interinstitutional exchange, collaboration and learning. It comprises a strategy of three phases and a toolkit with a set of instruments and accompanying measures that facilitate the innovation and business development process at affordable costs.²

- For rural communities, the framework provides a platform for them to express their needs, to get organized and to access agricultural advisory services.

- For international and national research institutes, the framework facilitates the dissemination of products and technologies. It permits close monitoring and provides high-quality data in near real time.
- For the private sector, the framework offers access to its rural network to do market research and to facilitate commercialization of their products and services.
- For the public sector, the framework provides a dashboard facilitating coordination and monitoring of the interventions of the various partners.
- For investors, the framework enables significant savings, as one network serves many partners. More importantly, AFRIS provides immediate feedback from the target group, thereby demonstrating ‘impact’.
- For young professionals, the framework provides an opportunity to gain professional experience and to develop their economic activities in the agricultural sector.

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1. For more information, see ‘A novel business model to engage youth to scale up technology adoption’, *AfricaRice annual report 2015*, page 19.
2. For greater detail on the framework, see An operational framework for innovation and youth employment at large scale. AgriNews Blog, 23 September 2018. Available at <<https://wiki.afris.org/display/AGN/2018/10/03/2018-09-23+An+Operational+Framework+for+Innovation+and+Youth+Employment+at+Large+Scale>>

AfricaRice and FAO continue to strengthen stakeholder capacity along the rice value chain

In 2016, AfricaRice and the Food and Agriculture Organization of the United Nations (FAO) reaffirmed their long-standing partnership by signing a Memorandum of Understanding (MoU) for ‘Scientific and technical cooperation in consolidating sustainable rice systems development in Africa’. Within the framework of this MOU, AfricaRice and FAO have conducted joint activities to enhance sustainable rice value chains in Africa – capacity development, knowledge exchange, and evidence-based analyses for policy development.

In at least 14 African countries, AfricaRice and FAO have helped strengthen national research and development capacity, and empowered rice producers, processors and business owners, with particular attention to young stakeholders and women.

In six Nigerian states, for instance, a training program on paddy production and multiplication of improved rice seeds enhanced the skills of over 300 young rice seed/paddy producers and community-based seed producers. Trainees learned good-quality seed

production techniques – from land preparation to post-harvest – through on-site demonstration and technical backstopping at the critical growth stages of rice. With a starter pack of 50 kg of breeder seed, they could produce foundation seed on one hectare of land, and they were linked to the National Agricultural Seed Council (NASC) for business registration and certification as seed producers in their states. AfricaRice received several requests to implement similar training in other states.

Meanwhile, 30 women parboilers from Gagnoa, Côte d’Ivoire were empowered with two units of the GEM parboiling system. Following training on improved parboiling practices and installation of the units in their processing areas, the quality of the parboiled rice in Gagnoa improved significantly. Better quality translated into a higher market price (an additional 50–100 FCFA per kilogram) and a net increase in income for the women parboilers. These women are now aware that quality matters and, because good parboiled rice starts with a good-quality paddy, they are changing the entire value chain.

AfricaRice and FAO are more than ever committed to replicate such successes in various African countries to strengthen rice value chains and contribute to rice self-sufficiency on the continent.

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Practical demonstration of marking out of nursery beds, Edo State, Nigeria

Partnerships

AfricaRice saw a surge in demand for collaboration in 2018. The Center entered into no less than seven new partnership agreements, which address key priority areas of the rice value chain to enable countries attain their rice self-sufficiency objectives.

The following partnership agreements contributed to delivery in three key areas needing development and investments: (1) enhanced seed systems to develop rice seed capital in Africa, (2) enhanced capacity

development of rice value-chain actors and (3) out-scaling of technologies and innovations.

A framework cooperation agreement between AfricaRice and Université Nangui Abrougoua (UNA, Abobo-Adjamé, Abidjan) in November is strengthening human resources development in Côte d'Ivoire. Master's students from UNA have already visited the M'bé research station to explore topics of interest to work on with supervision from AfricaRice scientists.



Signing ceremony for the cooperation agreement between AfricaRice and OCP Côte d'Ivoire, May 2018: Lahcen Ennahli, OCP Africa Senior Vice President for West Africa (left) with AfricaRice Director General, Dr Harold Roy-Macauley

After the signing of a Memorandum of Understanding (MoU) with Afe Babalola University (ABUAD, Ado-Ekiti, Ekiti State, Nigeria) in 2017, the year saw preparations for AfricaRice to participate in the ‘Youth employment in agribusiness and sustainable agriculture’ project funded by the International Fund for Agricultural Development (IFAD).

In the area of capacity development and employment of youth, an MoU was signed in December with Africa Projects Development Centre (APDC), an Abuja-based for-profit organization focusing on incubating, training, coaching, mentoring and empowering African youths in agribusiness, project design and project management. An action plan is under development for rice seed production by youth in Niger State, Nigeria, and for joint courses on business development, procurement and project design, to be taught at the AfricaRice Regional Training Center in Saint-Louis, Senegal.

For outscaling of rice technologies and innovations, AfricaRice signed an MoU with the World Vegetable Center (WorldVeg, Taiwan) in March. A joint proposal focusing on peri-urban rice–vegetable systems in inland valleys has been submitted to the European Union representation in Liberia for funding.

A framework collaboration agreement signed with the African Agricultural Technology Foundation (AATF) in June is in the same vein of outscaling of rice technologies. AATF is a ‘policy enabler’ in the

‘Technologies for African agricultural transformation’ (TAAT) project that AfricaRice is a part of. One aim of the new partnership is to promote hybrid rice uptake by the private sector.

AfricaRice entered into a cooperation agreement with OCP-Côte d’Ivoire (OCP-CIV) in May (based on a framework agreement signed in 2016 with the OCP Group, formerly Office chérifien des phosphates) to deliver on quality seed production and establish rice seed capital. A pilot project is being implemented with OCP-CIV support to the tune of US\$ 2 million, for the production of 2100 tonnes of certified rice seed to be promoted in Côte d’Ivoire along with appropriate fertilizers.

In February, AfricaRice signed an MoU with Manobi Africa Group, a private organization based in Mauritius, with expertise in the use of digital solutions to generate value-chain efficiency. The two organizations tested the Rice Value Chain–Resource Center model using the agCelerant value-chain orchestration platform, which incorporates information and Earth-observation technologies into e-solutions tailored specifically to the needs of smallholders to improve the performance of the rice value chain in communities around M’bé, Côte d’Ivoire.

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Finance

The AfricaRice management is pleased to report the improving financial situation of AfricaRice during the year ended 31 December 2018. The following are the highlights of the financial results:

Financial situation

The total operating revenues of the Center decreased from US\$ 19.262 million in 2017 to US\$ 17.481 million in 2018, corresponding to a decrease of US\$ 1.781 million. The operating expenses also decreased from US\$ 21.203 million in 2017 down to US\$ 17.177 million in 2018, corresponding to a decrease of US\$ 4.026 million. This resulted in AfricaRice recording an operational surplus of US\$ 0.304 million in 2018 against the operational deficit of US\$1.941 million in 2017. Additionally, the net non-operating financial expenses reduced the annual surplus for the year to US\$ 0.158 million compared to the deficit of US\$ 3.351 million incurred at the end of 2017. The undesignated net assets of the Center increased from US\$ 2.394 million at end of 2017 to US\$ 2.928 million at the end of 2018.

Other indicators of financial health

The short-term solvency (liquidity) indicator level of the Center was improved to 90 days, up from 70 days as indicated for 2017, and the long-term financial stability ratio was similarly improved to 62 days up from 44 days as indicated for 2017. The audited indirect cost rate for AfricaRice increased to 16.9% during the year, from 10.8% in 2017, as indicated. The current ratio increased from 1.35 in 2017 to 1.38 in 2018, which is within the CGIAR recommended level (greater than 1.0).

Summary Financials (expressed in thousands of US\$)

	2018	2017
Income statement		
Revenues	17,481	19,262
Operating surplus/(deficit)	304	(1,941)
Surplus/(deficit) for the year	158	(3,351)
Balance sheet		
Fixed assets (NBV)	3,424	3,624
Working capital	4,182	3,819
Non-current liabilities	2,349	2,345
Net assets		
Undesignated	2,928	2,394
Designated	2,328	2,704

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

	Total 2018	Total 2017
Revenue and gains		
Grant revenue		
Windows 1 and 2	4,222	3,807
Window 3	2,560	4,323
Bilateral	9,860	10,744
Total grant revenue	16,642	18,873
Other revenue and gains	839	388
Total revenue and gains	17,481	19,262
Expenses and losses		
Research expenses	13,339	17,153
CGIAR collaboration expenses	–	188
Non-CGIAR collaboration expenses	1,355	1,807
General and administration expenses	2,483	2,055
Other expenses and losses	–	–
Total expenses and losses	17,177	21,203
Operating surplus/(deficit)	304	(1,941)
Gain/loss on sale of assets	4	35
Restructuring cost/others	–	(1,260)
Financial income	15	6
Financial expenses	(166)	(190)
Surplus/(Deficit) for the year	158	(3,351)

List of donors

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

- AfricaRice Member States
- African Development Bank (AfDB)
- Arab Bank for Economic Development in Africa (BADEA)
- Belgium
- Bill & Melinda Gates Foundation
- Biotechnology and Biological Sciences Research Council (BBSRC)/ Department for International Development (DFID)
- Canada
- Chinese Academy of Agricultural Sciences (CAAS)
- CGIAR Research Program on Agriculture for Nutrition and Health (A4NH)
- CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)
- CGIAR Platform for Big Data in Agriculture
- CGIAR Research Program on Policies, Institutions, and Markets (PIM)
- CGIAR Research Program on Rice Agri-food Systems (RICE)
- Côte d'Ivoire
- Crop Trust
- European Union (EU)
- Food and Agriculture Organization of the United Nations (FAO)
- The Gambia
- German Federal Ministry of Economic Cooperation and Development (BMZ)
- German Society for International Cooperation (GIZ) GmbH
- International Fund for Agricultural Development (IFAD)
- Japan (MAFF, MOF, MOFA)
- Japan International Cooperation Agency (JICA)
- Japan International Research Center for Agricultural Sciences (JIRCAS)
- Liberia
- Madagascar
- Nigeria
- Netherlands Organisation for Scientific Research (NWO)
- 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)
- West and Central African Council for Agricultural Research and Development (WECARD/CORAF)
- World Bank

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(As at 31 December 2018)


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* Joined in 2018




AfricaRice training program (courses)

 **71** Training courses run in 2018

 **36** Locations  in **14** countries


 **6,176** Total trainees

Postgraduate trainees

 **19** Total female postgrads


 **46** Total male postgrads

 From **23** countries

 **37** PhD students
... of whom

 **12** Female

 **25** Male

 **18** MSc students
... of whom

 **5** Female

 **13** Male

 With **31** universities


 In **16** countries

 **18** Funding sources

Publications 2018

AfricaRice publications 2018

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

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

 **5** Book chapters

 **27** Conference papers

 **4** Articles in *Rice Today*

 **13** Others / reports

 **24** Videos
... in **2** languages

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Abbreviations

AATF	African Agricultural Technology Foundation
ABUAD	Afe Babalola University (Nigeria)
AfDB	African Development Bank
AfricaRice	Africa Rice Center
AFRIS	African Innovation Services (NGO)
APDC	Africa Projects Development Centre (Nigeria)
BMZ	Federal Ministry for Economic Cooperation and Development (Germany)
CARD	Coalition for African Rice Development
CARI	Competitive African Rice Initiative (GIZ)
CEMA	Center for Mechanized Services
CIPA	Capitalizing the Inland Valley Potential for Food and Nutrition Security for Smallholder Farmers in West Africa
CIPRiSSA	Continental Investment Plan for Accelerating Rice Self-Sufficiency in Africa
CoM	Council of Ministers (AfricaRice)
CTA	Technical Centre for Agricultural and Rural Co-operation
CtEH	Crops to End Hunger (CGIAR initiative)
EMF	early morning flowering
EPSOT	early peak spikelet opening time
FAO	Food and Agriculture Organization of the United Nations
FARA	Forum for Agricultural Research in Africa
FCFA	CFA franc(s)
GIAE	Green Innovation Centres for the Agriculture and Food Sector
GEM	Grain quality enhancer, Energy-efficient and durable Material
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GRIN-Global	Germplasm Resource Information Network
ICT	information and communications technology
IFAD	International Fund for Agricultural Development
IRAG	Institut de recherche agronomique de Guinée
IRRI	International Rice Research Institute (IRRI)
MoU	Memorandum of Understanding

NASC	National Agricultural Seed Council (Nigeria)
NERICA-L	New Rice for Africa (family of interspecific rice varieties for lowlands)
NGO	non-governmental organization
OCP-CIV	OCP-Côte d'Ivoire
PEJERIZ	Promoting Youth Entrepreneurship and Job Creation in West Africa's Rice Value Chain
RICE	Resilience, Industrialization, Competitiveness, and Empowerment
RUN	Rural Universe Network
SPEI	standardized precipitation evapotranspiration index
SRP	Sustainable Rice Platform
STRASA	Stress Tolerant Rice for Poor Farmers in Africa and South Asia (project)
t	tonne(s)
TAAT	Technologies for African Agricultural Transformation (project)
UK	United Kingdom of Great Britain and Northern Ireland
WorldVeg	World Vegetable Center

About CGIAR

CGIAR is a global research partnership for a food-secure future. CGIAR science is dedicated to reducing poverty, enhancing food and nutrition security, and improving natural resources and ecosystem services. Its research is carried out by 15 CGIAR Centers in close collaboration with hundreds of partners, including national and regional research institutes, civil society organizations, academia, development organizations and the private sector.

For more information, visit www.cgiar.org

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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