CGIAR Research Program on Rice Agri-Food Systems (RICE)

2020 Annual Report

The CGIAR Research Program on Rice Agrifood Systems (RICE) represents a single strategic and work plan for global rice research. RICE brings together hundreds of scientists to embark on the most comprehensive attempt ever to harness the power of science to solve the pressing development challenges of the 21st century. Cutting-edge science is deployed to develop new rice varieties with high yield potential and tolerance of a variety of stresses such as flooding, salinity, drought, soil problems, pests, weeds, and diseases. Improved natural resource management practices will allow farmers to fully realize the benefits of such new varieties on a sustainable basis while protecting the environment. Future rice production systems are designed to adapt to climate change and to mitigate the impacts of global warming. Policies conducive to the adoption of new varieties and cropping systems will be designed to facilitate the realization of development outcomes. RICE will train future rice scientists and strengthen the capacity of advisory systems to reach millions of farmers. For impact at scale, RICE scientists collaborate with hundreds of development partners from the public and private sector across the globe.

RICE was launched in 2010 (phase I: 2010-2016 – also known as the Global Rice Science Partnership, GRiSP; Phase II: 2017-2021) and is coordinated by three members of the CGIAR Consortium—the International Rice Research Institute (IRRI, the lead institute), Africa Rice Center (AfricaRice), the International Center for Tropical Agriculture (CIAT)—and three other leading agricultural agencies with an international mandate and with a large portfolio on rice: Centre de Cooperation Internationale en Recherche Agronomique pour le Développement (Cirad), L'Institut de Recherche pour le Développement (IRD), and the Japan International Research Center for Agricultural Sciences (JIRCAS). Together, they align and bring to the table consortia, networks, platforms, programs, and collaborative projects with over 900 partners from the government, nongovernment, public, private, and civil society sectors.

Mailing address: Dr. Bas Bouman, RICE program director, c/o IRRI, DAPO Box 7777, Metro Manila, Philippines
Phone: +63 (2) 580-5600
Fax: +63 (2) 580-5699
Email: b.bouman@irri.org
Web site: ricecrp.org

Suggested citation: RICE (CGIAR Research Program on Rice Agrifood Systems). RICE Annual Report 2020. Los Baños (Philippines): International Rice Research Institute.

Table of Contents

COVER PAGE

Name of the CRP: Rice

Name of Lead Center: IRRI

Flagship lead institutions (CGIAR Centers or lead partners)

Flagship 1: Accelerating impact and equity

Flagship 2: Upgrading rice value chains

Flagship 3: Sustainable farming systems

Flagship 4: Global Rice Array

Flagship 5: New rice varieties

Other participating Centers: AfricaRice, CIAT (Alliance), CIRAD, IRD, IRRI, JIRCAS

EXECUTIVE SUMMARY

A study was carried on adoption of several improved rice management practices in Africa, Asia, and Latin America. In four of the 13 provinces in the Mekong River Delta in Vietnam, nearly 70,000 hectares qualify as fully adopting the 3 Reductions-3 Gains or 1 Must-do 5 Reductions technologies. In Rio Grande do Sul in Brazil, the study found a total land area under 'Project 10' or Project 10+' practices to be over 60,000 hectares. Across Nigeria, Ghana, Benin, and Togo, the Smart-Valley system has been adopted on about 3,000 hectares.

The digital management advisory service 'RiceAdvice' and basic good agricultural practices were disseminated to a total of 14,900 farmers in Nigeria and Senegal. In Uruguay, improved management practices increased profitability by 7.6% as compared with conventional management.

Good progress was achieved with rice value chain upgrading in Nigeria, where AfricaRice established the Goronyo Rice Innovation Platform, which processed around 23 tons of paddy each month and generated $3,800 revenue and $584 profit.

For the Global Rice Array, we built a successful network with 22 sites distributed across Asia, Africa, and Latin America. Partners contributed yield, climate, and soil data from 53 trials for 42 entries of the Antenna Panel and from 18 trials 300 entries of the Reference Panel.

A global 'OneRice' breeding strategy was launched, realigning/mapping breeding pipelines across CGIAR

Centers and NARES partners. Global rice growing areas were segmented based on rice producers' and consumers' preferences. Product concepts were developed for each of the priority market segments. Annual genetic yield increases of about 0.68% (irrigated control), 0.87% (moderate reproductive stage drought stress), and 1.9% (severe reproductive stage drought stress) were reported from a multi-year study in India.

RICE contributed to the development of 6 policies, and developed 10 fully documented Outcome and Impact Case study Reports of which four were at adoption/impact level 2 and six at level 3.

RICE produced/updated 130 innovations. The innovations lined up nicely along the impact pathways, with around 47% in the discovery stage, 16% having been successfully piloted, and 52% available for take up and/or or proven to have been taken up by large numbers of end users.

Out of the 31 Milestones set for 2020, 20 were completed, nine extended, and two changed - mainly because of the impacts of covid-19.

RICE researchers published 277 peer-reviewed journal papers, of which 201 were open access (https://grispnetwork.groupsite.com/folders/285858). 11 papers were published in a journal with an impact factor above 10, with the highest being 42.

RICE centers and partners provided short term capacity development to 57,597 participants, (34% female). Participants were professionals, scholars, farmers, partners (government, NGO, private sector, etc), and other actors in rice value chains. Throughout the year, a total of 267 scholars (45% female) were enrolled in long-term capacity development programs.

Through the six RICE centers, there were 263 contractual arrangements (through bilaterally-funded projects) that involved 466 global, regional, and national partners from international, government, NGO, civil society, academic and private sectors. https://grispnetwork.groupsite.com/folders/285858.

Part A: NARRATIVE SECTION

1. Key Results

1.1 Progress Towards SDGs and SLOs (sphere of interest, with research results frequently predating the CRP) (max. 400 words)

Adoption of Smart-Valley management practices in Africa started with 110 ha in 2012 to 474 ha in 2014. Recent evidence shows the practices have been practiced on 45,000 ha in Nigeria. In 2019, the practices were adopted by 6,110 farmers in Benin and Togo covering some 1,031 hectares. In Sierra Leone, they

were adopted by 460 rice farmers, covering 179 hectares. The adoption of the smart-valley practices increased rice income with 440 US$/ha in Sierra Leone and Liberia.

RiceAdvice is a free Android application that provides farm-specific advice on rice management practices. In 2020, there were 14,900 beneficiaries of RiceAdvice in Nigeria. Impact assessment using randomized control trial in northern Nigeria showed that households who were just given the personalized advice increased their yield by 7% and increased their profit by 10%.

In the previous two decades, RICE created and disseminated regionally-designed and locally-appropriate portfolios of agronomic practices in collaboration with local partners. These agronomic practices include 3 Reductions - 3 Gains (3R3G) and 1 Must Do - 5 Reductions (1M5R) in Vietnam, Project 10 and 10+ Practices in Brazil, and Smart-Valley or Sawah in West Africa. Based on recent monitoring data from four of the 13 provinces in the Mekong River Delta in Vietnam, we find nearly 70,000 hectares qualified as fully adopting 3R3G or 1M5R. Using project monitoring data from the state of Rio Grande do Sul in Brazil, we found the total land area under Project 10 or 10+ to be over 60,000 hectares. Across Nigeria, Ghana, Benin, and Togo, we are able to confirm that Smart-Valley/Sawah had been adopted on about 3,000 hectares.

Findings from economic surplus analysis indicate that the net present value of IRRI's contributions to rice varietal yield changes in Bangladesh over the 1990-2018 period ranged from US$ 3.3 to 6.5 billion. The net present value of IRRI investments in Bangladesh in the water-saving practice of Alternate Wetting and Drying ranged from US$ 14 to 146 million, and in Site Specific Nutrient Management technology from US$ 140 million to US$ 148 million.

We determined the annual rate of genetic gain for rice grain yield in a drought-prone rainfed system in a series of multi-environment trials conducted from 2005 to 2014 under the Drought Breeding Network of Indian sites: 0.68 % under irrigated conditions, 0.87 % under moderate reproductive-stage drought, and 1.9 % under severe reproductive-stage drought.

1.2 CRP Progress towards Outputs and Outcomes (spheres of control and influence)

1.2.1 Overall CRP progress (max 1000 words)

Findings from economic surplus analysis conducted at IRRI indicate that the net present value of IRRI's contributions to rice varietal yield changes in Bangladesh over the 1990 to 2018 period ranges from USD 3.3 billion to USD 6.5 billion. A new study at AfricaRice recommended that policymakers should include gender mainstreaming as part of the core mandate of research institutions. This will enable research institutions to consider gender issues from the onset and make gender forms an integral part of research and development process. Government should invest in the development and promotion of gender-sensitive improved rice technologies for inclusiveness, equity and sustainability of rice sector. A study was

carried on adoption of several improved rice management practices in Africa, Asia, and Latin America. In four of the 13 provinces in the Mekong River Delta in Vietnam, nearly 70,000 hectares qualify as fully adopting the 3 Reductions-3 Gains or 1 Must-do 5 Reductions technologies. In Rio Grande do Sul in Brazil, the study found a total land area under 'Project 10' or Project 10+' practices to be over 60,000 hectares. Across Nigeria, Ghana, Benin, and Togo, the Smart-Valley system has been adopted on about 3,000 hectares. The digital management advisory service 'RiceAdvice' and basic good agricultural practices were disseminated to a total of 14,900 farmers in Nigeria and Senegal. In Uruguay, improved management practices increased profitability by 7.6% as compared with conventional management.

In terms of value chain strategies, a major piece of work was CIRAD, AfricaRice and IRRI's assessment of the state of rice value chain upgrading in 15 West African countries, which can assist policymakers in West Africa. Great progress was achieved with rice value chain upgrading in Nigeria, where AfricaRice established the Goronyo Rice Innovation Platform, which processes around 23 tons of paddy each month and generates US$3,800 revenue and US$584 profit. A major output was IRRI's book on sustainable rice straw management, which can assist policy makers in reducing greenhouse gas emissions and air pollution in South and Southeast Asia. Good progress was also made in Myanmar, where mechanized practices were found to significantly reduce postharvest losses and increase net income by 30-50%. With respect to novel product upgrading and development, IRRI published a database to help value chain actors introduce novel products in Indian diets. AfricaRice demonstrated a methodology for the production of fortified rice-based products.

An IoT (Internet of Things) based irrigation advisory service (AutoMonPH) decision that entails efficient water management, continuous monitoring, reporting and verification of water management practices, and a multi-stakeholder interface was developed and piloted in the Philippines. In Africa, a basket of options on climate-smart technologies was presented at the ECOWAS Consultative Meeting on Rice Offensive (West Africa region’s Rice Development Strategy). The management advisory system RiceAdvice and basic good agricultural practices were disseminated to a total of 14,900 farmers in Nigeria and Senegal. In Uruguay, improved management practices increased profitability by 7.6% as compared with conventional management, whereas there was no yield difference between the practices. This increase was mainly due to the use of less seed and less nitrogen per area unit. A short video was developed to support the dissemination of the decision support system WeRise and a designated website was developed to obtain relevant management solutions and information. The short video was released through Facebook and YouTube and viewed 1,200 views.

For the Global Rice Array, we built a successful network with 22 sites distributed across Asia, Africa, and Latin America. Partners sent yield, climate, and soil data from 53 trials for the antenna panel (AP) of 42 entries and from 18 trials for the reference panel (RP) of 300 entries. Partners received analysis tools (R-Scripts) for phenotypic data and were able to analyse their trials. This guided development of varieties, adapted to specific environments, since 35 entries from the AP were selected by partners as promising lines and used in local breeding pipelines. High-throughput-phenotyping tools were successfully used by three CGIAR centers and one NARES partner in India. Preliminary analysis of 2019 AP and RP data, using both within and across site AMMI (additive main effects and multiplicative interaction) analyses for GxE,

showed site groupings of traits. Genome Wide Association Studies (GWAS) revealed site specific and common QTLs across studied environments. Tools for GWAS analysis were added to CropGalaxy and virtual training was performed. The diseases Bacterial Leaf Blight, Rice Yellow Mottle Virus, Brown Spot and Blast were characterized in Africa, Asia, and Latin America. Its diversity was used to design molecular markers and to improve pathotracer ability to predict varietal deployment. Microbiome diversity was explored in China.

A global OneRice breeding strategy was launched, realigning/mapping breeding pipelines across CGIAR Centers and NARES partners. Regional NARES partner networks were expanded, including the establishment of an ASEAN RiceNet. The global rice growing areas were segmented in meaningful pieces based on rice producers' and consumers' preferences. Product concepts were developed for each of the priority market segments. The analysis of breeding work done by the Drought Breeding Network in India and IRRI during 2005-2014 showed positive trend in grain yield with annual genetic yield increases of about 0.68% (irrigated control), 0.87% (moderate reproductive stage drought stress), and 1.9% (severe reproductive stage drought stress). Seventeen new genes for major diseases and pests in the IRRI154 background were released and made available to the breeders. These have never been available in elite backgrounds before, and this marks a step-change in breeding for these traits. Four high-yielding varieties were evaluated and released in Niger for irrigated lowlands including one salt tolerant and aromatic variety. AfricaRice-FOFIFA started developing red rice varieties with high yield potential. Through FLAR, CIAT nominated new breeding lines for multi-environment testing and release, and issued high-Zn varieties in Latin America and the Caribbean. Cirad-FOFIFA developed three new varieties for Madagascar’s mid-high altitude areas, similar to Nerica4 but more productive. IRRI bred 9 varieties and 3 hybrids which were released by various national programs in Asia and Africa.

1.2.2 Progress by flagships

F1 - Flagship progress:

Findings from economic surplus analysis conducted at IRRI indicate that the net present value of IRRI’s contributions to rice varietal yield changes in Bangladesh over the 1990 to 2018 period ranges from USD 3.3 billion to USD 6.5 billion.

A new study at AfricaRice recommended that policymakers should include gender mainstreaming as part of the core mandate of research institutions. This will enable research institutions to consider gender issues from the onset and make gender forms an integral part of research and development process. Government should invest in the development and promotion of gender-sensitive improved rice technologies for inclusiveness, equity and sustainability of rice sector.

An adoption study led by University of Arizona revealed that based on monitoring data from four of the 13 provinces in the Mekong River Delta in Vietnam, nearly 70,000 hectares qualify as fully adopting 3R3G or 1M5R (8% of total rice area). Using project monitoring data from the state of Rio Grande do Sul in Brazil, the study finds total land area under Project 10 or 10+ to be over 60,000 hectares (6% of total rice

area). Across Nigeria, Ghana, Benin, and Togo, Smart-Valley has been adopted on about 3,000 hectares (0.04% of potential inland valleys).

Detailed Annex:

With the support of SPIA and the RICE CRP, IRRI and University of Arizona conducted the first phase of the project "Evaluating the Impact of Stress-Tolerant Rice Varieties Through Remote Sensing and Econometric Methods". Remote sensing techniques were used to examine flooding and the density of green vegetation in the flood-prone areas of Bangladesh.

A noticeable policy engagement is the recent IRRI contribution to the dialogue on Rice Tarification Law (RTL) in the Philippines. Based on two studies on RTL published in 2020, the Foresight team proposed policy measures that the Philippine government can use to help rice farmers to adapt and develop profitable business in agriculture or outside, particularly those who are negatively impacted by the reform. In particular, the IRRI's study emphasized that investments and policy support measures are needed in rural areas of the Philippines to create more opportunities for on-farm diversification towards higher value crops than rice.

A new study at IRRI examined the effect of IRG ancestry on the rice productivity of farmers in Eastern India in an econometric framework. The study also examines the country of origin of all IRG accessions in the ancestry of improved rice varieties grown and characterizes the most widely used progenitors. Results indicate that a 10% increase in the genetic contribution of IRG accessions to an improved rice variety is associated with a yield increase of 27%.

Rapid population growth in Africa and Asia is projected to lead to an unprecedented number of youth entering the labour market in the next few decades. Youths' role in agriculture or the agri-food sector has received increased interest as a way to provide employment opportunities for young job seekers given the "demographic dividend" most developing countries are showcasing. Engaging youth is a broad concept which depends on broader socio-economic factors ranging from age, gender, educational level, access to credit, ownership of land, kinship, marriage, and type of affiliations with social or institutional networks, to list a few. In 2020, IRRI developed a strategy plan for Youth in rice agri-food systems in Asia and Africa. The strategy lays out two important components 1) The framework of engagement encompassing the objectives, research areas, and theory of change and 2) A plan for operationalizing the strategy. The IRRI's 5-year youth strategy aims to increase our knowledge and generate evidence about the situation and needs of youth engaged in the rice AFS so that the sector can become an attractive and remunerative livelihood opportunity, including employment and entrepreneurship. Through implementing this Youth Strategy, IRRI seeks to become a knowledge and innovation pioneer and take a leadership role in bringing young people to the forefront of rice AFS. The first two years (2020-22) will involve research to establish the foundational understanding of youth in rice AFS and designing action research plans and interventions for the following years. The medium term (2022-2025) will be focused on facilitating the creation of opportunities for youth in rice AFS in Asia and Africa. This will involve setting

strong partnerships for research for development and testing interventions with the aim to learn from them.

A recent study at AfricaRice investigates the linkages between gender, development and utilization of technological innovations in Ghana and made the following recommendations:
(1) Gender issues are not identified and addressed during the technology development process. Lack of consultation with the target group throughout the agricultural innovation development process is likely to create room for the development of undesirable characteristics of improved rice technologies.
(2) Although participatory varietal selection (PVS) is conducted, bringing various target groups, women are generally unable to freely express themselves when in the company of male counterparts. Women are also constrained by time due to their relative pre-occupation with domestic activities. Women are hence disadvantaged in terms of contributing to the innovation development process.
(3) Research institutions' mandate does not emphasize gender mainstreaming, but food security and livelihood improvement. In the absence of institutional transformation and incentives, gender issues are not addressed in ARD.
(4) Low implementation of gender mainstreaming policies and/or strategies by the research institutions is due to the lack of gender training and capacity building for scientists and research managers.
(5) Since gender mainstreaming is more theoretical than practical, policymakers should include gender mainstreaming as part of the core mandate of research institutions. This will enable research institutions to consider gender issues from the onset and make gender forms an integral part of research and development process.
(6) Given that women rice farmers' needs and concerns differ from that of their male counterparts, the government should invest in the development and promotion of gender-sensitive improved rice technologies for inclusiveness, equity and sustainability of rice sector.

Relevance to Covid-19:

Due to the COVID pandemic, several household surveys planned in 2020 could not be implemented due to travel restrictions. For example, The Rice Monitoring survey in India and Bangladesh, which was planned to assess the impact of stress-tolerant varieties in South Asia, was postponed to 2021. The household survey about climate change adaptation in Bangladesh was postponed to 2021. In India, the phone-based interviews for household surveys were experimented, but the participation rate was small, as farmers were not used to this system, and for those who agreed to participate, many were reluctant to provide certain types of information. With the restrictions imposed in several countries due to the COVID pandemic, many of the policy engagement activities planned under 1.4 could not be implemented. In the Philippines, the presentation on RTL and engagement with the National Economic and Development Authority were slowed down. Virtual seminar and webinars were organized instead. In Latin America, COVID limited our capacity to return to the field and organize travels to implement research activities. In Africa, panel data in different countries could not be collected for 2020 due to lockdown in many countries. The time in 2020 was used to develop articles and press release to assess the potential impact of the pandemic and propose solution to different players. The paper on "Policy options for mitigating

impacts of COVID-19 on domestic rice value chains and food security in West Africa" was published in Global Food Security. Some on-farm trials in collaborations with FP3 on the dissemination of digital tools like RiceAdvice/Weed Manager were postponed due to the restriction to travel. Some activities in the Innovation Platforms were canceled due to the restriction of group meetings. The activity on deployment of the web-based platform in the Dagana IP in Senegal was canceled.

F2 - Flagship progress:

Despite the COVID-19 restrictions and thanks to the investments that were made prior to 2020, FP2 made good progress, albeit at the cost of a reduction in the number of sites. In terms of value chain strategies, a major piece of work was CIRAD, AfricaRice and IRRI's assessment of the state of rice value chain upgrading in 15 West African countries, which can assist policymakers in West Africa. Great progress was achieved with r ice value chain upgrading in Nigeria, where AfricaRice established the Goronyo Rice Innovation Platform, which processes around 23 tons of paddy each month and generates US$ 3,800 revenue and US$ 584 profit. A major output was IRRI's book on sustainable rice straw management, which can assist policy makers in reducing GHG emissions and air pollution in South and Southeast Asia. Good progress was also made in Myanmar, where mechanized practices were found to significantly reduce postharvest losses and increase net income by 30-50%. With respect to novel product upgrading and development, IRRI published a database to help value chain actors introduce novel products in Indian diets. AfricaRice demonstrated a methodology for the production of fortified rice-based products. JIRCAS' activities on pop rice were postponed to 2021.

Relevance to Covid-19:

In response to the COVID-19 pandemic, several studies were initiated by FP2: 1. AfricaRice, CIRAD and IRRI published the policy brief “Policy options for mitigating impacts of COVID-19 on domestic rice value chains and food security in West Africa” in Global Food Security, which was featured by the World Trade Organization in Trade for Development News. The study builds on evidence of the current state of domestic rice value chain upgrading in West Africa to anticipate the impacts of the COVID-19 pandemic on rice value chains’ resilience and their capacity to sustain food security in the region. Several policy options are proposed to help West African governments mitigate the impacts of the COVID-19 crisis on food security. 2. AfricaRice, CIRAD and IRRI followed up the study in Global Food Security by a COVID-19 focused study "Reducing rice import dependency in West Africa: focusing beyond production”, which is under review at Scientific African. The study argues that increasing local rice supply requires support to downstream segments (millers and traders) in the value chain to assist them in upgrading local rice quality and competing against and replacing imports. While food security could be increased through self-sufficiency in rice, addressing climate, weather and market challenges are also required to increase resilience of rice value chains and sustainably secure local rice supplies in West Africa. This is of crucial importance during and after pandemic outbreaks such as COVID-19. 3. IRRI initiated a study on the impact of COVID-19 on rice-based diets and consumers’ attitudes towards nutrition interventions. This

study is a synergy between the BBSRC funded SuperNutrientRice project and a Special Research Fund sandwich program with Ghent University, Belgium.

F3 - Flagship progress:

Flagship Project 3 (FP3) "Sustainable Farming Systems" had 6 milestones in 2020 (see Table 5). Despite challenges of COVID-19, we completed almost all milestones. As for new innovation, an IoT based irrigation advisory service (AutoMonPH) decision that entails efficient water management, continuous monitoring, reporting and verification of water management practices, and a multi-stakeholder interface was developed and piloted in the Philippines. In Africa, A basket of options on climate-smart technologies were presented in ECOWAS Consultative Meeting on Rice Offensive (West Africa region's Rice Development Strategy) in 4 - 5 Feb, 2020. RiceAdvice" together with basic good agricultural practices (GAP) were disseminated to a total of 14900 farmers in Nigeria and Senegal in 2020. In Uruguay, improved management practices increased profitability by 7.6% as compared with conventional management, whereas there was no yield difference between two management practices. This increase is mainly due to the use of less seed and less nitrogen per area unit. WeRise short video was developed for potential users to increase their awareness of this ICT and let as many users as possible access a designated website to obtain a relevant solution and information. The short video was released through Facebook and YouTube and obtained 1,200 views.

Detailed Annex:

IRRI: The Sustainable Rice Platform (SRP) was promoted in Vietnam through a field demonstration (13 ha) combining the 'Small Farmers - Large Field' model, the management practices '1 Must Do - 5 Reductions' (1M5R), and SRP guidelines. This generated several scientific based evidences of the management practices '1M5R and mechanized transplanting such as: mean grain yield and net income increased by 5-10%; reduced seed rate by 40-60%, reduced pesticide application by 30-40%, and reduced greenhouse gases by 30%. A survey was conducted in the Philippines to review the government policies supporting agricultural mechanization and assess the management and utilization of mechanical transplanters including the perception of various stakeholders. Reasons for poor adoption of Alternate Wetting and Drying (AWD) in Bangladesh were identified. Results of field study conducted for three years (2016–2019) in Polder 30 in Bangladesh identified promising cropping systems with improved varieties.

AfricaRice: In Rwanda, country-specific good agricultural practices (GAP were developed. 45 demonstration plots were established to disseminate the GAPs and 1080 rice farmers were trained though farmer field days in Rwanda. Promising site-specific nutrient management practices were identified in Rwanda, Senegal, and Tanzania. Impact of AWD on yield, water productivity, and weeds were quantified in Côte d'Ivoire. Crop diversification options were jointly tested with farmers in Cote d'Ivoire, Madagascar, Senegal, and promising options were identified together with farmers. Promising pieces of small-scale sowing equipment (seeders and fertiseeder) were developed which can reduce the labour

input for sowing by 70-80% compared to manual sowing in Madagascar.

CIAT: A pilot project with a private company in Panama was launched in 2020 to increase productivity and reducing production costs. Results from the first demonstration plots showed average production cost was reduced by 22.3% and profitability was doubled as compared to conventional management. The FLAR's (Latin America foundation for irrigated rice) Rice/Soybean Rotation Project began in 2015 with the objective of validating the adaptation of soybean cultivars and establishing agronomic management practices for rotation systems with rice in the tropical zone of Latin America and the Caribbean. As a result of this project, Nicaragua, through its Rice Farmers Association, is facilitating the registration and seed commercialization, by a private company, of at least one soybean variety introduced by FLAR from Brazil. Same result was obtained in Colombia, where the National Rice Farmers association facilitated the registration and multiplication of two soybean varieties introduced by FLAR. In Venezuela, soybean became the most valuable alternative for rotation with rice, as a consequence on this project. At this point, research and commercial agreements for soybean variety release and seed production are ongoing with funding and capacities allocated by FLAR partners themselves.

CIRAD: In Madagascar, multi-year experiments on bio-diversified upland rice based cropping systems were evaluated. Participatory designing identified promising diversification options including maize, cassava, pulses and legume cover crops as rotational crops. In Cambodia, farm typology in the major rice production area was carried-out. In Ivory Coast, upland rice based direct seeding systems under conservation agriculture had more climate resilience than conventional systems with tillage. In Burkina-Faso, on farm trials on lowland rice system showed (i) a high carry-over effect of potatoes rotation with rice for soil fertility; and (ii) a good profitability (return on investment) of low dose urea land-filling at sowing for rice subject to floods.

JIRCAS: In Madagascar, field experiment revealed that Stylosanthes guianensis (stylo) absorbed 10-26 times higher P uptake than rice, maize, or soybean under typical P-deficient uplands in the region. Subsequent field experiment in the next season showed that the yield of upland rice in where stylo was previously cultivated was greater than those grown after maize or rice. Considering the high biomass and high P absorption capacity, and the effect on subsequent rice yield, stylo can be a promising option as cover/relay crop to enhance P cycling in upland rice-based cropping system under P-deficient condition in the region.

Relevance to Covid-19:

Due to Covid-19, FP3 annual workshop was cancelled in 2020. We used this fund to conduct impact assessment of COVID-19 on crop production and food security in Senegal and Tanzania, where rice production could be impacted by localized and time-sensitive lack of labour, limited or delayed availability of inputs through planted area reduction, delay in planting, or the inability of carrying out critical crop management practices, potentially leading to reduce yield.. This pilot assesses the impact of COVID-19 on rice production using remotely-sensed rice area/production changes, combined with field surveys

identifying production factor changes and socio-economic impacts. Up to now, the datasets (field, ancillary GIS data, and imagery) were assembled and completed. In 2021, the team will work for the rice area maps and changes in Tanzania, the yield maps and changes in Senegal and Tanzania, as well as the socio-economic surveys, analysis and reporting. The pilot is providing a first great opportunity to gain experience and apply the RICE experience, developed in Asia, to the African context, where rice monitoring data and capacities are very limited, if not inexistent on the continent. In particular, it allowed to start a collaboration between IRRI, AfricaRice, and SARMAP on these geospatial applications. In Latin America, from March 15 2020, all in-person training activities and field days were cancelled. These training activities were adapted to virtual formats. In total, 32 virtual training sessions in crop management were offered, at no charge, for participants from all LAC countries. In addition, five virtual field days were offered. An estimated of more than 2,500 people were reached in these virtual events. A video was produced on the decision-support system WeRise short video alongside a designated website to access the tool.

F4 - Flagship progress:

We built a successful network with 22 sites distributed across Asia, Africa and Latin America. Partners sent yield, climate and soil data from 53 trials for the antenna panel (AP) of 42 entries and from 18 trials for the reference panel (RP) of 300 entries. Partners received analysis tools (R-Scripts) for phenotypic data and were able to analyse their trials. This guided development of varieties, adapted to specific environments, since 35 entries from the AP were selected by partners as promising lines and used in local breeding pipelines. High-throughput-phenotyping tools were successfully used by three CGIAR centers and one NARES (India). Preliminary analysis of 2019 AP and RP data, using both within and across site AMMI (additive main effects and multiplicative interaction) analyses for GxE, showed site groupings of traits. GWAS results revealed site-specific and common QTLs across studied environments. Tools for GWAS analysis were added to CropGalaxy (a web-based platform for bioinformatic and statistical tools), and virtual training was performed. The diseases Bacterial-Leaf-Blight, Rice-Yellow-Mottle-Virus, Brown Spot and Blast were characterized in Africa, Asia and Latin America. With diversity used to design molecular markers and to improve PathoTracer's ability to predict varietal deployment. Microbiome diversity was explored in China.

Detailed Annex:

For Coa 4.2: The main limitation was to maintain local personnel in NARES experimental stations. For instance, data on the RP for 4 sites was stored in a database. Software was developed to optimize image analysis, and new tools to estimate climate response variables such as panicle fertility were developed. For Coa 4.5: Genotype data is in crop galaxy and phenotype data is available through the Project website, it is not yet in Galaxy. Progress was hampered due personnel constraints.

Relevance to Covid-19:

Virtual workshops on bioinformatics were used for virtual training on analysis tools. Some planned trials for CoA 1 and 2 could not be completed depending on the quarantine status of trial locations. These were postponed and are now underway during dry season 2021. No new studies of relevance to Covid -19 could be integrated into this FP.

F5 - Flagship progress:

FP5 (New Rice Varieties) launched a global OneRice breeding strategy, realigning/mapping breeding pipelines across CGIAR Centers and NARES. Networks of regional NARES partners were expanded, including establishment of ASEAN RiceNet. The global rice growing areas were segmented in meaningful pieces based on rice producers and consumers preferences. Product concepts were developed for each of the priority market segments. Research done by the Drought Breeding Network and IRRI during 2005-2014 showed positive trend in grain yield with annual genetic yield increase of about 0.68% (irrigated control), 0.87% (moderate reproductive stage drought stress), 1.9% (severe reproductive stage drought stress). Seventeen new genes for major diseases and pests in the IRRI 154 background were released and made available to the breeders. These have never been available in elite backgrounds before, and this marks a step-change in breeding for these traits. Four high yielding varieties were evaluated and released in Niger for irrigated lowlands including one salt tolerant and aromatic variety. AfricaRice-FOFIFA started developing red rice varieties with high yield potential. Through FLAR, CIAT nominated new breeding lines for MET and release, and issued high Zn varieties in LAC. Cirad-FOFIFA developed three new varieties for Madagascar's mid-high altitude areas, similar to Nerica4 but more productive. IRRI bred 9 varieties and 3 hybrids which were released by the various national programs in Asia and Africa.

Detailed Annex:

Several initiatives are being done commonly be multiple Centers:
Global maturity system: Efforts were initiated to define and establish a global relative maturity system in collaboration with RICE CGIAR Centers and private sector partners.
Lowering the glycemic index (GI): One protocol for rice processing was identified and used by AfricaRice to evaluate different rice varieties. Three very promising Low GI rice (GI=20-22) products were identified and can be used as parents for breeding low GI rice. IRRI investigated the GI of breeding and develop materials in vitro and found that many of them are in the high GI levels. Screening of 320 Genebank materials identified 3 donor lines validated through in vivo human feeding trials as low GI.
Product management initiative: Product managers were hired for Asia and East and Southern Africa to develop product profiles of key rice popular varieties and developed recommendations for product positioning of new products.
High Throughput Phenotyping for head rice recovery and grain Zn estimation: IRRI acquired several

Zaccaria PAZ-1/DTA test mills to enable HRR phenotyping – 5 units are for use in HQ and 3 units are for India and Bangladesh. Several XRF machines were also acquired for Zn phenotyping.
Zinc biofortification: In Latin America and the Caribbean, CIRAD and CIAT developed new breeding material and conducted regional multiplication trials to release varieties with increased grain Zn concentration. JIRCAS also collaborated with CIRAD on Zn biofortification in Madagascar (with HarvestPlus and FOFIFA). New high-Zn donors having more than twice the grain Zn concentration compared to local variety X265 were identified using Genomic Selection. High-Zn breeding lines from CIAT/CIRAD were tested and 5 lines combining local adaptation with high grain Zn were selected for a possible fast-track variety release. Evaluations under the direction of the seed board of Madagascar are ongoing.
Publications: Six peer-reviewed articles were published in scientific journals, two more papers are currently under review. One paper came out in early 2021 reporting findings of a study conducted on genetic gain over the period 2005 to 2014.

Relevance to Covid-19:

At IRRI, shutdowns associated with the covid-19 pandemic have had severe impacts, with the loss of the entire 2020 greenhouse experiments (RGA cohorts, New F1s and seed purity) and 2020 dry season trials at HQ. The lockdown delayed re-entry of skeleton staff in mid-May, almost like a domino-effect, caused delay in regional seed shipments (1.5-2 months), and trial establishment. This resulted in delayed data collection and uploading from the regional NARES partner teams, and thereby in analyses timeline. The effects continued to be felt through short staffing, creating difficulties in establishing the 2020 wet season crop. The travel bans and lock downs severely affected the ability to work at optimal level. AfricaRice cancelled (1) multi-location and on-farm trials which required farmers groups to indicate new variety preferences, resulting in varietal release only in Niger, and (2) MET trials of NARES partners with the Breeding Task Force due to severe restrictions of movement between regions. CIAT recovered field and laboratory activities in April to June. Following biosafety protocols of reduced number of staff, some activities were reduced in size. Most donors allowed movement of travel budgets to other kinds of support for projects. In CIRAD, there was delay in genomic selection, breeding for low input in Madagascar, developing high Zn rice for LAC and Madagascar, activities on the Gene Network Model, and training on new GE tools. In IRD, developing the Python version of the NOISYmputer algorithm was delayed making it impossible to impute whole-genome sequencing data with a newer, optimized algorithm. In JIRCAS, breeding activities progressed almost as planned. Collaborative decision-making with NARES counterparts was affected since all joint field visits were cancelled. Capacity building was affected – hands-on training of 4 young (2 female) counterpart scientists at JIRCAS were cancelled and replaced by online training.

1.2.3 Variance from Planned Program for this year (max 450 words)

A) Have any promising research areas been significantly expanded?

We examined the disease's impact on the rice sector and several research articles and policy briefs were published. New research questions and funding opportunities have emerged as a result of the covid-19 pandemic. Our foresight research has been expanded with scenarios of the development of the covid-19 pandemic. Also, national policy engagement activities have been expanded. Research on food choice for healthier diets has expanded as response to the demand as articulated by the CGIAR Executive Management Team.

B) Have any research lines been dropped or significantly cut back?

No field surveys were conducted because of the many travel restrictions that were imposed to limit the spread of covid-19. Also because of these travel restriction, and because of reductions in allocated budget, research activities planned under CoA 1.3 "Collective Innovation and Seed Systems" have been reduced. Activities planned under the Impact-Oriented Monitoring and Evaluation (IOMEL) strategy of CoA 1.6 that could not be implemented were postponed to 2021, in particular, the capacity development initiatives and the promotion of impact culture. However, we were able to conduct a virtual training on "Fast Track impact" with the University of New Castle.

C) Have any Flagships or specific research areas changed direction?

Except for specific covid-19 related activities, no major changes in direction were implemented. AfricaRice, Cirad, and IRRI published the policy brief “Policy options for mitigating impacts of covid-19 on domestic rice value chains and food security in West Africa” in Global Food Security, which was featured by the World Trade Organization in Trade for Development News. Several policy options were proposed to help West African governments mitigate the impacts of the covid-19 crisis on food security. AfricaRice, Cirad, and IRRI followed up the study in Global Food Security by a Covid-19 focused study "Reducing rice import dependency in West Africa: focusing beyond production”. This study argues that increasing local rice supply requires support to downstream segments (millers and traders) in the value chain to assist them in upgrading local rice quality and competing against and replacing imports. IRRI initiated a study on the impact of covid-19 on rice-based diets and consumers’ attitudes towards nutrition interventions. This study is a synergy between the BBSRC-funded SuperNutrientRice project and a Special Research Fund sandwich program with Ghent University, Belgium.

1.2.4 Altmetric and Publication highlights (max. 400 words)

276 peer-reviewed papers were published of which 73% were open access (https://grispnetwork.groupsite.com/folders/285858).

Altmetrics score 295: Oliva, Norman, Maria Florida Cueto-Reaño, Kurniawan R. Trijatmiko, Mercy Samia, Ralf Welsch, Patrick Schaub, Peter Beyer, Donald Mackenzie, Raul Boncodin, Russell Reinke, Inez Slamet-Loedin, and B. P. Mallikarjuna Swamy. Molecular characterization and safety assessment of biofortified provitamin A. rice Scientific Reports 10, no. 1376 (2020): 13 p. doi: 10.1038/s41598-020-57669-5. Part of the studies involved in safety assessment of genetically engineered crops includes characterizing the organization, integrity, and stability of the inserted DNA and evaluating the potential allergenicity and toxicity of newly-expressed proteins. Molecular characterization of the introduced DNA in provitamin A biofortified rice event GR2E confirmed insertion of a single copy of the transfer-DNA in the genome and its inheritance as a single locus. Nucleotide sequencing of the inserted DNA confirmed it was introduced without modifications. The phytoene synthase, and carotene desaturase proteins did not display sequence similarity with allergens or toxins. Both proteins were rapidly digested in simulated gastric fluid and their enzymatic activity was inhibited upon heat treatment. Acute oral toxicity testing of the protein in mice demonstrated lack of adverse effects. These evidences substantiated the lack of any identifiable hazards for both proteins and in combination with other existing comparative analyses provided assurance that food derived from this rice is safe. This conclusion is in line with those of the regulatory agencies of US Food and Drug Administration, Health Canada and Food Standard Australia and New Zealand

Altmetrics score 200: Van Der Straeten, Dominique, Navreet K. Bhullar, Hans De Steur, Wilhelm Gruissem, Donald MacKenzie, Wolfgang Pfeiffer, Matin Qaim, Inez Slamet-Loedin, Simon Strobbe, Joe Tohme, Kurniawan Rudi Trijatmiko, Hervé Vanderschuren, Marc Van Montagu, Chunyi Zhang, and Howarth Bouis. Multiplying the efficiency and impact of biofortification through metabolic engineering, Nature Communications 11, no. 5203: 1-10. doi:10.1038/s41467-020-19020-4. Ending all forms of hunger by 2030, as set forward in the UN-Sustainable Development Goal 2, is a daunting but essential task, given the limited timeline ahead and the negative global health and socio-economic impact of hunger. Malnutrition or hidden hunger due to micronutrient deficiencies affects about one third of the world population and severely jeopardizes economic development. Staple crop biofortification through gene stacking, using a rational combination of conventional breeding and metabolic engineering strategies, should enable a leap forward within the coming decade. A number of specific actions and policy interventions are proposed to reach this goal.

1.3 Cross-cutting dimensions (at CRP level)

1.3.1 Gender (max. 750 words)

A) List any important CRP research findings

IRRI conducted a study on gender-based constraints in rice seed production in Bangladesh. Farmers' limited scope of using quality seeds relates to the demand and supply gap. Inequitable access to quality seeds is due to lack of awareness and weak market linkages. An investigation by AfricaRice of the linkages between gender, development, and utilization of technological innovations was conducted in Ghana. It

found that gender issues are not identified and addressed during the technology development process.

Little is known about the role of gender in demand for premium rice quality attributes such as fragrance. A better understanding of the drivers of demand may help connecting farmers to high value markets. To respond to this data gap, IRRI published the results of a survey with 4,231 urban and rural consumers in 37 cities across seven countries in South and Southeast Asia (Bangladesh, India, Cambodia, Indonesia, Philippines, Thailand, Vietnam). Demand for rice fragrance is found to be mainly driven by women; the more women are empowered in grocery decision-making, the more demand for aromatic rice is expected to rise. These insights can assist market-driven and gender-responsive rice breeding programs in simultaneously enhancing rice farmers' livelihoods and gender equity.

African women associations tend to be involved in postharvest activities and marketing in rice, which is a powerful entry point for value chain upgrading to empower them. AfricaRice conducted a consumer study on branding and labeling, which provides crucial insights into the upgrading strategies that can empower women associations in the marketing of rice in Benin and other countries in Africa.

AfricaRice analyzed the labor inputs in rice-based farming systems within a gender perspective. Results show that women and men spend on average 1–3 h per day in rice production, making 45–135 working days of involvement in annual rice cultivation. Looking into the distribution of labor input provision in productive activities, it is found that apart from the specific activity of rice parboiling, which is practiced in certain countries mostly by women, men are the ones more engaged in rice farming. These results provide the first evidence that women farmers do not necessarily spend more time than men in rice cultivation in Africa, as it is often assumed. Certainly, across countries and systems, and also within male and female farmers categories, there are heterogeneous labor inputs and associated determining factors and incomes. Male farmers earn higher income than female farmers in the different productive activities, except rice parboiling. This finding indicates that increasing labor input for rice would not result in higher income for female farmers. Female farmers might find better options in other agricultural activities such as processing.

B) What have you learned? What are you doing differently?

Seed systems do not directly lead to women's empowerment and gender equality. To achieve this, seed system interventions require specific and targeted objectives, such as the promotion of women's access to resources; women's voice in household and community decision-making; and addressing structural barriers to women's participation.

Our consumer studies have shown time after time that women can play an instrumental role in driving demand (e.g., fragrance in Asia) or driving marketing (e.g., Africa). We now more explicitly account for these gender-specific drivers in product upgrading (e.g., the development of gender-responsive product profiles for breeding or extrinsic quality attributes through branding and labeling) and process upgrading (e.g., we focus on parboiling to empower women).

Results from labor distribution analysis suggest that while rice research community often focuses on reducing labor inputs for rice cultivation by female and increasing female labor productivity through introduction of mechanization or its service provision business, such an approach has limitations and misses the whole context of household labor allocation. We need to consider a holistic approach for enhancing entire labor productivity by female (income per labor time) in the context of the broad farming system.

C) Have any problems arisen in relation to gender issues or integrating gender into the CRP's research?

There was no problem in relation to gender issues or integrating gender into the CRP's research

1.3.2 Youth and other aspects of Social inclusion / "Leaving No-one Behind" (max 600 words)

IRRI and AfricaRice developed a Strategy for Youth Engagement in Rice Agri-food Systems Research for Development on the horizon 2020-2025. The objective of the RICE youth strategy is for youth to contribute to, and benefit from, inclusive and sustainable transformation of rice agri-food systems. New research areas have been identified from the youth strategy:

· Youth relationships to rice agri-food systems and their aspirations;
· Drivers and predictors of youth engagement in transforming rice agri-food systems;
· Establish the profitability of rice value chain at different nodes in different contexts – scenarios with collective action and horizontal and vertical coordination;
· Understanding how youth engage in and benefit from existing supply chains or service provision;
· Designing and testing new models of finance and land tenure to engage youth in rice agri-food systems;
· Testing public-private partnerships to catalyze investments for youth in rice agri-food systems at different scales;
· Analyzing, designing, and testing urban-rural linkages in the context of urbanization and digital revolution – create an ecosystem of collaboration among urban and rural youth; and
· Evidence generation to understand pathways for change benefiting and driven by youth.

To support indigenous communities in the Cordillera Autonomous Region and preserve rice cultural heritage in the Philippines, IRRI conducted a consumer survey in Metro Manila to develop a segmented marketing strategy for heritage-rice farming. Findings indicate that women, business owners, and consumers who buy packaged rice and eat pigmented rice are willing to pay more for heritage rice produced by indigenous communities. Proper information framing will be necessary to create demand and support the valorization of heirloom rice to preserve cultural heritage and in situ biodiversity of rice landraces in the Philippines.

AfricaRice closely works with youth service providers for scaling of the decision-support system RiceAdvice. In 2020, 73% are youth (124 youths) in Nigeria, whereas all 20 service providers are youth in

Senegal, who were identified by Rice Cooperatives Unions from Senegal. In Nigeria, these youth are mainly identified by farming groups.

A) List any important CRP research findings

Innovation platforms are excellent entry points for youth involvement. AfricaRice's Goronyo Rice Innovation Platform in the Middle Rima Valley Irrigation Scheme (MRVIS) in Nigeria is a good example. 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 collaboration. The various rice value chain upgrading activities often involve training of young farmers, value chain actors, or students. It is expected that introducing young actors to innovations has large multiplicator effects in the long run as these actors may inspire their peers to become innovation champions.

Investigation of the involvement of youth in extension activities revealed that they only participate in a limited way in on-farm trials and have low access to extension. The finding confirms the opportunity for utilizing ICT tools in extension; capacity building for the youth is needed on using these tools. In turn, the ICT tools need to be simple and accessible (https://grispnetwork.groupsite.com/folders/28...).

B) What have you learned? What are you doing differently?

Recent interviews conducted in Mali and Senegal revealed that the AfricaRice-CTA project contributed to facilitate youth's access to finance and ensured a proper capacity building through specific training and coaching/mentorship to support economic activities for a better livelihood.

We can go further in involving youth. Youth can play an important role as influencers in consumption. FP2 is increasingly including youth in the impact pathways as influencers for socially responsible consumption. For example, through social media campaigns, millennials or generation Z can contribute to climate change mitigation by promoting the consumption of rice produced with lower greenhouse gas emissions. This idea has been incorporated in a few project proposals.

For effective use of the ICT tools, capacity building is essential for the youth. AfricaRice provided training on use the ICT tool (decision-support system) RiceAdvice to youth service providers. In 2020, 73% of trained people were youth (124 youths) in Nigeria, whereas all 20 service providers are youth in Senegal.

C) Have any problems arisen in relation to youth issues or integrating youth into the CRP's research?

There was no particular problem in relation to youth issues or integrating youth into the CRP's research.

1.3.3 Capacity Development (max. 300 words)

Capacity development was affected by covid-19 in the sense that many on-site events had to be postponed or even cancelled, while most events that did proceed were organized virtually with online courses and materials provided. Nevertheless, RICE centers and partners till managed to provide short-term capacity development to 57,597 participants, of which 34% were female. Participants were professionals, scholars, farmers, partners (government, NGO, private sector, etc), and other actors in rice value chains. Throughout the year, a total of 267 scholars (45% female) were enrolled in long-term capacity development (BsC, masters, PhD, interns and on-the job-trainees).

AfricaRice's experience with capacity development in the Goronyo Rice Innovation Platform in the Middle Rima Valley Irrigation Scheme (MRVIS) in Nigeria provides a good example of how capacity development can be deployed as an engine for rice value chain upgrading. 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. This example demonstrates how building capacity of value chain actors opens up many opportunities that range from increased efficiency and output to access to new market channels and industry knowledge. https://cgiar-my.sharepoint.com/:b:/r/persona...;web=1e=7Um8Gl

Another example of capacity development is the training of 170 service providers and extension agents from Nigeria and 20 from Senegal in the use of the rice management support system RiceAdvice. In Rwanda, 1,080 rice farmers were trained in good agricultural practices though farmer field days. A Sustainable Rice Platform training course was organized in alliance with GLOBALG.A.P with 15 participants from eight countries in Latin America and the Caribbean. An online training for the use of the decision-support system WeRise was provided to 51 agricultural extension workers and 22 national researchers in Philippines and Indonesia.

1.3.4 Climate Change

Intersectoral upgrading of rice value chains through the development of novel rice straw management practices and markets for rice straw is probably the area where rice value chain upgrading can contribute most to climate change mitigation. IRRI's book on rice straw management evidences this impact pathway by (1) identifying, developing, and verifying technologies and business models for sustainable rice straw management; (2) conducting market studies on existing and potential rice straw product markets; (3) establishing data on greenhouse gas emissions from different rice straw management and processing practices; (4) determining environmental footprints using life cycle assessment; and (5) formulating policy recommendations.

Trial sites for the antenna (AP) and reference panels (RP) of the Global Rice Array to study the effects of climate change 'through the eyes of the crop' were conducted using manual, and in some cases unmanned aerial vehicles, phenotyping. Entries in the AP panel cover tolerances for stresses such as blast, heat, drought, submergence. The diversity of the plant microbiome of modern and traditional varieties were compared, and the microbiome community was found to significantly vary depending on the variety. Rice crop models were improved to better capture the effect of high temperature.

Various climate-smart management practices were further developed and tested. Impacts of Alternate Wetting and Drying on yield, water productivity, and weeds were quantified in Côte d'Ivoire. In Senegal, a new cropping calendar for double cropping could lead to a cumulative annual yield increase by 3.2 t/ha (30%). In Ivory Coast, upland rice-based direct seeding systems under conservation agriculture had more climate resilience than conventional systems with tillage. Through on-farm validations in two provinces in Indonesia and three in the Philippines, the application of the decision-support system WeRise increased fertilizer use efficiencies and grain yields by optimizing sowing time of rainfed rice.

2. Effectiveness and Efficiency

2.1 Management and governance (max. 300 words)

No changes in the RICE management or governance structure occurred in 2020; terms of references of governance and management bodies can be accessed here (http://www.grisp.net/file_cabinet/folders/265910). The RICE independent steering committee did not meet this year because of travel restrictions imposed by covid-19 response measures.

2.2 Partnerships

2.2.1. Highlights of External Partnerships (300 words)

Through the six RICE centers, there were 263 contractual arrangements (through bilaterally-funded projects) that involved 466 global, regional, and national partners from international, government, NGO, civil society, academic and private sectors. https://grispnetwork.groupsite.com/folders/285858.

2.2.2. Cross-CGIAR Partnerships (300 words)

Cross-CGIAR partnerships concentrated on the platform Excellence in Breeding (EiB) and the new initiative Excellence in Agronomy, and on the CRPs Policies, Institutions, and Markets (PIM) and FISH. IRRI actively contributed to the activities and publications of the CGIAR Foresight Team, including the development of the CGIAR Foresight Report, and the Future of X that provides perspectives on food, land

and water systems in developing countries. On the basis of these studies, new collaborations have been established with other centers (World Fish, CIP, etc.) to examine the future trend of rice-based systems and, in turn, guide the agri-food transformation. RICE staff also actively participated in the PIM COVID-19 value chain fractures working group: collecting and reviewing evidence of COVID-19 inflicted fractures in food value chains in the developing world.

The collaboration with EiB focused on the modernization and upgrading of breeding systems, the use of Crop Galaxy by CG and partners, and the development of market intelligence and product profiles.

The Excellence in Agronomy 2030 Initiative was launched in 2020. A 2-yr incubation project has been funded by BMGF.

2.3. Intellectual Assets (max. 250 words)

Have any intellectual assets been strategically managed by the CRP (together with the relevant Center) this year?

The RICE CRP is not a legal entity and the management of legal assets relevant to the CRP is managed by its participating CGIAR centers. All RICE CGIAR centers annually prepare and submit a detailed (usually labeled confidential) intellectual asset report to the System (Management) Board and the information contained therein is not repeated here.

Indicate any published patents and/or plant variety right applications (or equivalent)

See above

List any critical issues or challenges encountered in the management of intellectual assets in the context of the CRP

See above

2.4 Monitoring, Evaluation, Impact Assessment and Learning (MELIA) (max. 200 words)

A foresight study - together with PIM and other CGIAR Centers - analyzed the impacts of rural transformation on the future of cereal-based agri-food systems. The study stressed that the staples maize, wheat, and rice will continue to play an important role in supplying most of the daily calories intake around the globe.

2.5 Efficiency (max. 250 words)

As RICE has stabilized by now and has entered a 'winding down' phase, there were no new efficiency gains beyond what was reported in previous years. Moreover, the covid-19 pandemic negatively affected previously-developed efficiency gains through travel and meeting restrictions.

2.6 Management of Risks to Your CRP (max. 250 words)

Risks were primarily related to the covid-19 pandemic. Travel restrictions affected field work, surveys, partner interaction, and capacity development. Face-to-face training and workshop events were replaced by online mechanisms, field work was mostly done by local partners, while most surveys were postponed to 2021. On the other hand, more time was available for data analysis, synthesis, and publication writing, and for development of new project proposals. Also, several covid-19 specific research activities were undertaken (see covid-19 sections in this report).

Institutionally, uncertainty about the OneCGIAR reorganization, institutional and programmatic changes, and funding uncertainty led to considerable anxiety among staff members. Uncertainty existed about continued collaboration with nonCGIAR partners beyond the CRPs.

2.7 Use of W1-2 Funding (Max. 250 words)

In general, W1,2 funding provided the backbone of RICE and catalyzed impact through strategic investments along the whole impact pathway, from upstream research to downstream development of business models and multistakeholder partnerships for innovation and scaling out. W1,2 investments included both the research and product development component of the impact pathway as well as the strengthening of the enabling environment (as per Theory of Change). The long-term nature of W1,2 funding provides the continuity to the program, and guarantees both short-term and long-term impacts on 5-10 year time scales. With the declining W1,2 budget, the available fund for most Flagship Projects was used conservatively to support staff time and planned activities. In several cases, the W1,2 fund was used to leverage with existing bilateral grants. With the limited number of staff available, several research activities were implemented through consultancies funded by W1,2. Selected examples in Table 12 provide some details of activities across the RICE Flagship Projects supported with W1,2 funds.

3. Financial Summary

For the fourth year in a row, the actual W1,2 funds received were below the programmed allocation as per 2021 Revised FinPlan endorsed by the System Board on 23 November 2020 (pursuant to decision SB/M18/DP5) and approved by the System Council on 17 December 2020 (pursuant to decision SC/M10/EDP9). This year, the received W1,2 funds were 10.122 M USD, around 4 M USD short of the allocated 13.915 M USD. The total amount of W3/bilateral funds was 42.509 M USD, which was some 3 M

USD below the target of 45.815 M USD. This drop may be explained by a decrease in mapped bilateral projects because of the winding down of the CRPs by the end of 2021.

The data in Table 13 may still undergo minor changes as at the time of writing, the budget distribution among clusters of activity by one of the partners still needs to verified.

Part B. TABLES

Table 1: Evidence on Progress towards SRF targets (Sphere of interest)

SLO Target (2022)	Brief summary of new evidence of CGIAR contribution	Expected additional contribution before end of 2022	Geographic Scope
100 million more farm households have adopted improved varieties, breeds, trees, and/or improved management practices.	In the previous two decades, RICE created and disseminated regionally-designed and locally-appropriate portfolios of agronomic practices in collaboration with local partners. These agronomic practices include 3 Reductions - 3 Gains (3R3G) and 1 Must Do - 5 Reductions (1M5R) in Vietnam, Project 10 and 10+ practices in Brazil, and Smart-Valley or Sawah practices in West Africa. Based on recent monitoring data from four of the 13 provinces in the Mekong River Delta in Vietnam, we find nearly 70,000 hectares qualify as fully adopting 3R3G or 1M5R. Using project monitoring data from the state of Rio Grande do Sul in Brazil, we find total land area under Project 10 or 10+ to be over 60,000 hectares. Across Nigeria, Ghana, Benin, and Togo, we are able to confirm that Smart-Valley/Sawah has been adopted on about 3,000 hectares and by by 6,110 farmers in Benin and Togo. https://economics.arizona.edu/dissemination-and-adoption-bundled-agronomic-practices		•Geographic Scope: Multi-national. •Countries: Benin, Brazil, Nigeria, Togo, Viet Nam, Ghana.
	RiceAdvice is a free Android application that provides farm-specific advice on rice management practices to farmers. RiceAdvice can identify the best choice of fertilizers to be purchased, their amounts and application timing, based on nutrient requirement and fertilizer prices. Using the app, farmers can also select their own target yield level based on their budget. RiceAdvice does not require internet connection to generate the guidelines, except for updating the app. In 2020, there were 14,900 beneficiaries of RiceAdvice in Nigeria. https://www.africarice.org/riceadvice		•Geographic Scope: National. •Countries: Nigeria.
30 million people, of which 50% are women, assisted to	Iron toxicity is one of the most important constraints limiting rice production in lowland sub-Saharan Africa. To improve rice productivity in the affected areas in the context of climate change, new rice varieties with genetic resistance to iron toxicity were developed and released in SSA. This study used a randomized controlled trial to assess the effect of an		•Geographic Scope: Regional. •Regions: Sub-

exit poverty	iron toxicity-tolerant variety, ARICA6, on the rice production and income of smallholder farmers. Results showed that the use of the ARICA6 variety increased rice yield by 330 kg ha-1 and net income by US$ 120 ha-1. Average technical efficiency increased by 7%. The large-scale dissemination of ARICA6 could be a policy option to revive rice production and reduce food insecurity for rice producers, but additional measures such as reducing the constraints due to unpredictable rainfall through improved water management are needed to further increase the benefits. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3592455		Saharan Africa.
	Adoption of the Smart-Valley (or Sawah) approach increased from 110 ha in 2012 to 474 ha in 2014. Recent evidence shows that the approach has reached 45,000 ha in Nigeria. In 2019, the total area increased to 1,031 ha in Benin and Togo where it was adopted by 6,110 farmers. In Sierra Leone, the adoption area was 179 ha by 460 farmers. Results show that the impact of Smart-Valley on rice income is an additional 440 US$/ha for adopters in Sierra Leone and Liberia.		•Geographic Scope: Multi-national. •Regions: Sub-Saharan Africa. •Countries: Benin, Liberia, Sierra Leone, Togo.
	RiceAdvice is a free Android application that provides farm-specific advice on rice management practices to farmers. Impact assessment using randomized control trials in northern Nigeria showed that households who were just given the personalized advice increased their yield by 7% and their profit by 10%.		•Geographic Scope: National. •Regions: Sub-Saharan Africa. •Countries: Nigeria.
	Building the capacity of small-scale seed producers for certified seed production is seen as a viable solution to help attain the twin objectives of the availability of quality seed and farmer empowerment. Additionally, by strengthening small-scale seed producers, they can potentially play a major role in ensuring seed security for the underserved farmers. Led and managed by women, The Adarsh Dharmagarh Women Farmers Services Producer Company Ltd (ADWFSPCL), is being incubated by IRRI, the Odisha Department of Agriculture and Farmers' Empowerment, and Access Livelihoods Consulting India since 2019. In the same year, around 180 women members of ADWFSPCL produced about 350 tons of paddy seed planted on 72.5 ha in the kharif season and on 157 ha in the rabi season. The ADWFSPCL was registered as seed producer by the Odisha State Seed and Organic Products Certification Agency with support from the Department of Agriculture. http://books.irri.org/Odisha-Annual-Report-2019-2020.pdf		•Geographic Scope: National. •Regions: Sub-Saharan Africa. •Countries: India.
Improve the rate of yield increase for major food staples from current < 1% to 1.2-1.5% per year	Iron toxicity is one of the most important constraints limiting rice production in lowland sub-Saharan Africa. To improve rice productivity in the affected areas in the context of climate change, new rice varieties with genetic resistance to iron toxicity were developed and released in SSA. This study used a randomized controlled trial to assess the effect of an iron toxicity-tolerant variety, ARICA6, on the rice production and incomes of smallholder farmers. Results showed that the use of the ARICA6 variety increased rice yield by 330 kg ha-1, while the average technical efficiency increased by 7%.		•Geographic Scope: Regional. •Regions: Sub-Saharan Africa.

	A variety of Green Super Rice called NSIC Rc 480 was able to almost double its maximum yield per hectare, from 4.4 tons to 8.3 tons, during the Palaysikatan Field Day of the Philippine Rice Research Institute in Sto. Tomas, Davao Del Norte, Philippines.		•Geographic Scope: National. •Regions: Sub-Saharan Africa. •Countries: Philippines (the).
	A randomized control trial was used to evaluate the effectiveness of a mobile application that provides personalized advice on rice nutrient management (RiceAdvice) in Africa. Results show that households who were just given the personalized advice increase their yield by 7%. On average, personalized advice increased yields without increasing the overall quantity of fertilizer used. (https://doi.org/10.1111/ajae.12151)		•Geographic Scope: National. •Regions: Sub-Saharan Africa. •Countries: Nigeria.
	Using a three years panel data from 520 farmers, results showed a positive impact of the adoption of the improved iron toxicity-tolerant variety ARICA 6 on yield, net income, and technical efficiency. The study found evidence that the use of the ARICA 6 variety increased yield by 330 kg ha-1. The average technical efficiency increased by 6%. (https://ssrn.com/abstract=3592455)		•Geographic Scope: National. •Regions: Sub-Saharan Africa. •Countries: Guinea.
	We determined the annual rate of genetic gain for rice grain yield in a drought-prone rainfed system in a series of multi-environment trials conducted from 2005 to 2014 under the Drought Breeding Network of Indian sites. Our results show a positive trend in grain yield with an annual genetic yield increase of about 0.68 % under irrigated control, 0.87 % under moderate reproductive stage drought stress and 1.9 % under severe reproductive stage drought stress due to breeding efforts. The study also demonstrates the effectiveness of direct selection for grain yield under both irrigated control as well as managed drought stress screening to improve yield in typical rainfed systems. IRRI's drought breeding programme has exhibited a significant positive trend in genetic gain for grain yield over the years under both drought stress as well as favorable irrigated control conditions. https://doi.org/10.1016/j.fcr.2020.107977		•Geographic Scope: National. •Regions: Sub-Saharan Africa. •Countries: India.
30 million more people, of which 50% are women, meeting minimum dietary energy requirements			
150 million more people, of which 50% are women, without deficiencies			

of one or more of the following essential micronutrients: iron, zinc, iodine, vitamin A, folate, and vitamin B12			
10% reduction in women of reproductive age who are consuming less than the adequate number of food groups			
5% increase in water and nutrient (inorganic, biological) use efficiency in agro-ecosystems, including through recycling and reuse			
Reduce agriculturally-related greenhouse gas emissions by 0.2 Gt CO2-e yr–1 (5%) compared with business-as-usual scenario in 2022			
55 million hectares (ha) degraded land			

area restored			
2.5 million ha of forest saved from deforestation			

Table 2: Condensed list of policy contributions in this reporting year (Sphere of Influence)

Title of policy, legal instrument, investment or curriculum to which CGIAR contributed (max 30 words)	Description of policy, legal instrument, investment or curriculum to which CGIAR contributed (30 words). See guidance for what to cover.	Level of Maturity	Link to sub-IDOs (max. 2)	CGIAR cross-cutting marker score				Link to OICR (obligatory if Level of Maturity is 2 or 3) or link to evidence (e.g. PDF generated from MIS)
				Gender	Youth	Capdev	Climate Change	
183 - Effective implementation of the 'seeds without borders' agreement in South Asia	A policy dialogue was organized and a book published about the effective implementation of the "Seeds Without Borders" Agreement and to encourage more countries to join the Agreement.	Level 2	• Conducive agricultural policy environment • Adoption of CGIAR materials with enhanced genetic gains • Agricultural systems diversified and intensified in ways that protect soils and water	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	OICR3866
628 - Policy tool for sustainable rice value chain development in Ghana	AfricaRice and FAO developed prospective analysis of rice value chain development with account for environmental impact. The net present value for the growth scenario is USD 378 million after investment.	Level 1	• Conducive agricultural policy environment • Enhanced institutional capacity of partner research organizations • Technologies that reduce women`s labor and energy expenditure adopted	1 - Significant	1 - Significant	1 - Significant	2 - Principal	The value chain approach provides a promising way of achieving sustainable development in the food sector in developing countries. Through an expansion strategy that would involve increasing the area cultivated for rice, instituting GAP and other improved production methods, the upgraded rice value chain would increase the value added by USD 378 million by 2030, reduce the carbon footprint of paddy from 1.4 to 0.7 tCO2-e/ tonne of paddy produced and

								increase employment - with approx. 60 600 additional jobs created by 2030
629 - Policy tool for sustainable rice value chain development and environmental impact in Cote d'Ivoire	AfricaRice and FAO developed prospective analysis of rice value chain development with account for environmental impact. The net present value for the growth scenario is USD 604 million after investment	Level 1	• Enhanced institutional capacity of partner research organizations • Enabled environment for climate resilience • Conducive agricultural policy environment	1 - Significant	1 - Significant	1 - Significant	2 - Principal	The value chain approach provides a promising way of achieving sustainable development in the food sector in developing countries. Through an expansion strategy that would involve increasing the area cultivated for rice, instituting GAP and other improved production methods, the upgraded rice value chain would increase the value added by USD 604 million by 2030, and increase employment - with approx. 234 000 additional jobs created by 2030. Green gas house emission will be reduce by 1.28 million tCO2-e equivalent to 38 million USD per year
630 - Policy tool for sustainable rice value chain development and environmental impact in Mali	AfricaRice and FAO developed prospective analysis of rice value chain development with account for environmental impact. The net present value for the growth scenario is USD 602 million after investment	Level 1	• Conducive agricultural policy environment • Enabled environment for climate resilience • Reduced net greenhouse gas emissions from agriculture, forests and other forms of land-use (Mitigation and adaptation achieved	1 - Significant	1 - Significant	1 - Significant	2 - Principal	The value chain approach provides a promising way of achieving sustainable development in the food sector in developing countries. Through an expansion strategy that would involve increasing the area cultivated for rice, instituting GAP and other improved production methods, the upgraded rice value chain would increase the value added by USD 602 million by 2030, and increase employment - with approx. 240 000 additional jobs created by 2030. Green gas house emission will be reduce by 2.2 millions tCO2-e equivalent to 66 millions USD per year

631 - Policy options for mitigating impacts of COVID-19 on domestic rice value chains and food security in West Africa	We build on evidence to propose policy options to help West African governments mitigate the impacts of the COVID-19 crisis on food security.	Level 1	• Conducive agricultural policy environment • Conducive environment for managing shocks and vulnerability, as evidenced in rapid response mechanism	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	Rice plays a strategic role in food security in West Africa. However, the region increasingly relies on rice imports due to a growing and structural deficit, and domestic value chains face constraints in technology, finance and coordination. As a result, West Africa is very vulnerable to international and local trade disruptions, such as the ones currently inflicted by the COVID-19 pandemic. We build on evidence of the current state of domestic rice value chain upgrading in West Africa to anticipate the impacts of the COVID-19 pandemic on rice value chains' resilience and their capacity to sustain food security in the region. Several policy options are proposed to help West African governments mitigate the impacts of the COVID-19 crisis on food security. We recommend policy makers to provide financial support to the "hidden middle", particularly rice millers, as crucial intermediaries in both traditional and upgraded rice value chains. Many West African countries have already allowed free movement of food (both paddy and milled rice) and we recommend this policy to be maintained, emphasized and monitored to foster efficient rice value operations during the pandemic period.
633 - Stop Covid-19 Crisis Morphing into A Food Crisis: Support To Africa's Rice Sector	The paper aims to inform decision-makers and other stakeholders in the rice sector in Sub-Saharan Africa about the	Level 3	• Conducive agricultural policy environment	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	1 - Significant	OICR3893

	potential impact of the COVID19 crisis to trigger actions.							

Table 3: List of Outcome/ Impact Case Reports from this reporting year (Sphere of Influence)

Title of Outcome/ Impact Case Report (OICR)	Link to full OICR	Maturity level
OICR2752 - Adoption of smart-valley approach in Benin, Togo, Nigeria, Liberia and Sierra Leone (as two new countries in 2020)	Link	Level 3
OICR2834 - RiceAdvice improved the livelihood of smallholder rice producers in Nigeria	Link	Level 2
OICR2850 - Implementation of regional rice value chain upgrading strategy in West Africa	Link	Level 2
OICR2934 - Impact assessment of stress-tolerant rice varieties: Evaluating impact through remote sensing and econometric methods	Link	Level 3
OICR2936 - Dissemination and Adoption of Bundled Agronomic Practices	Link	Level 2
OICR3866 - Policy dialogue for effective implementation of the Seeds Without Borders Agreement in South Asia	Link	Level 2

OICR3882 - New ARICA 6 variety to increase rice productivity and farmers? food security through adaptation to iron toxicity in lowlands	Link	Level 3
OICR3887 - Impact of the adoption of ASI thresher on the credit acquisition of rice farmers	Link	Level 3
OICR3892 - Rice value chain upgrading is dynamic in countries with high rice production and import bills	Link	Level 3
OICR3893 - Moving toward rice self-sufficiency in sub-Saharan Africa by 2030: Lessons learnt from 10 years of the Coalition for African Rice Development	Link	Level 3

Table 4: Condensed list of innovations by stage for this reporting year

Title of innovation with link	Innovation Type	Stage of innovation	Geographic scope (with location)
595 - SMART-Valleys: a new participatory approach for land and water management in Benin and Togo	Production systems and Management practices	Stage 4: uptake by next user (USE)	Multi-national
596 - RiceAdvice: an android based decision support tools for Nigeria	Production systems and Management practices	Stage 4: uptake by next user (USE)	National
599 - Cropping calendar construction model	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Multi-national
600 - Alternate wetting and drying (AWD) in Africa	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Regional, Sub-Saharan Africa
654 - MINCER micrometerological station used to improve spikelet sterility estimations in crop models	Biophysical Research	Stage 3: available/ ready for uptake (AV)	Global
810 - AfricaRice weather: a free web-database	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Regional, Sub-Saharan Africa

816 - Weather-rice-nutrient integrated decision support system (WeRise) in Indonesia	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National
818 - Weather-rice-nutrient integrated decision support system (WeRise) in Philippines	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National
823 - Enhanced P-cycling with stylosanthes (Stylosanthes guianensis) in upland rice-based cropping systems	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National
825 - Toolkit to capture diversity and drivers of food choice of a target population to identify entry points for novel food products and nutritional interventions	Social Science	Stage 3: available/ ready for uptake (AV)	Global
836 - Food Choice Application (FCA): An interactive tablet application for capturing diversity of food choice	Social Science	Stage 3: available/ ready for uptake (AV)	Global
855 - Policy sequencing framework for rice value chain upgrading	Social Science	Stage 4: uptake by next user (USE)	Regional, Western Africa
856 - Solar Bubble Dryer	Production systems and Management practices	Stage 4: uptake by next user (USE)	Global

859 - Rice straw downdraft furnace for paddy drying	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National
864 - New method and indicators for measuring inclusiveness of value chain upgrading	Social Science	Stage 3: available/ ready for uptake (AV)	Global
871 - Indicators and protocol to identify sustainable post harvest management practices	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Multi-national
876 - Market-based incentive mechanism for adoption of sustainable production standards throughout rice value chains	Social Science	Stage 3: available/ ready for uptake (AV)	Regional, South-Eastern Asia
880 - An automated approach for mapping inland valleys	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Sub-Saharan Africa
1015 - Enhancing rice farmers' food security through adaptation to iron toxicity in lowlands: evidence of ARICA 6 rice variety	Genetic (varieties and breeds)	Stage 4: uptake by next user (USE)	Regional, Western Africa
1018 - Sustainable Rice Platform (SRP) Standard and Performance Indicators in Africa	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Regional, Sub-Saharan Africa

1020 - Upland rice-based cropping systems with conservation agriculture in Ivory Coast	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	National
1021 - RiceAdvice-WeedManager	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Sub-Saharan Africa
1024 - RiceAdvice: an android-based application for rice crop management in Burkina Faso, Mali and Senegal	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Regional, Western Africa
1032 - Smart-Valleys approach in Burkina Faso, Liberia and Sierra Leone	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Multi-national
1036 - Optimal irrigation scheduling for off-season vegetable crops in Côte d'Ivoire	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National
1038 - Water management options for malaria and climate change mitigation in intensified rice production	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National
1039 - Good Agricultural Practices (GAP) for improving rice productivity in Senegal	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National
1041 - High potential inland valley maps for	Production systems and Management	Stage 2: successful piloting (PIL - end of	Multi-national

intensification in Cote d'Ivoire and Ghana	practices	piloting phase)	
1047 - Rice-legume and vegetables rotation systems in lowlands in C[illegible]e d'Ivoire	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	National
1049 - Mechanical seeders for direct seeded rice	Other	Stage 1: discovery/proof of concept (PC - end of research phase)	National
1050 - Fertiseeder, a manual seeder cum fertilizer micro-dose applicator	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National
1051 - Two Adapted Motorized Weeder (AMW) for irrigated and rainfed lowland systems in sub-Saharan Africa	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Regional, Sub-Saharan Africa
1052 - Two-row Motorized Paddy Weeder for Irrigated and Rainfed Lowland Systems	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Eastern Africa
1053 - Crop diversification options to improve farmers' livelihoods in Madagascar lowlands	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National
1054 - Mechanical weeders for rice production in Sub Saharan Africa	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Multi-national

1055 - Good Agricultural Practices (GAP) - Tanzania	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National
1056 - Good Agricultural Practices (GAP) - Madagascar	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National
1057 - Good Agricultural Practices (GAP) - Uganda	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National
1058 - Development of micronutrient fertilizer strategies for rice	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Sub-Saharan Africa
1406 - Economic Community of West African States (ECOWAS) regional action plan for rice self-sufficiency by 2025	Social Science	Stage 3: available/ ready for uptake (AV)	Regional, Western Africa
1413 - Access of youth agripreneurs to agricultural finance for entrepreneurship and self-employment	Social Science	Stage 3: available/ ready for uptake (AV)	Multi-national
1695 - Solar bubble dryer for mushroom drying	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Global

1697 - Flood tolerant variety IR13F265 (NSIC Rc 590)	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National, Philippines (the)
1701 - Salinity management in the delta of Senegal River Valley	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	National, Senegal
1710 - Perennial rice varieties for irrigated rice system in the Sahel	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Multi-national, Senegal
1718 - Libertad FL: A new rice variety for Venezuela	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Venezuela (Bolivarian Republic of)
1756 - Good Agricultural Practices (GAP) - Rwanda	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	National, Rwanda
1777 - Barinesa FL: A new Rice variety for Venezuela	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Venezuela (Bolivarian Republic of)
1778 - Araureña FL: A new rice variety for Venezuela	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Venezuela (Bolivarian Republic of)
1779 - Guariqueña FL: A new rice variety for Venzuela	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Venezuela (Bolivarian Republic of)

1780 - Nory FL: A new rice variety adapted to the western rice producing region of Venezuela	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Venezuela (Bolivarian Republic of)
1781 - Victoria FL: A rice variety with excellent cooking quality adapted to Ecuador	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Ecuador
1782 - CropGalaxy - a unified analysis platform for multiple crops	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Global
1783 - Diversity of pathogen in Africa	Other	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1785 - biofortified varieties Fedearroz BioZN-035	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Latin America & the Caribbean
1787 - INIAP ELITE FL: New rice variety for Ecuador	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Ecuador
1788 - GRDB 16 FL: New rice variety for Guyana	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Guyana
1791 - Ecological niche modeling approach for assessing potential for expansion of irrigated rice under alternate	Biophysical Research	Stage 2: successful piloting (PIL - end of piloting phase)	National, Burkina Faso

wetting and drying method			
1796 - Nitrogen efficient rice breeding line	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1798 - Identification of QTL for anaerobic germination from a biparental cross with the Aus donor, BJ1	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	Global
1799 - Development of high-quality new reference genomes for Asian rice	Other	Stage 3: available/ ready for uptake (AV)	Global
1800 - Training on CropGalaxy tools during Bioinformatics Community Conference 2020	Other	Stage 3: available/ ready for uptake (AV)	Global
1802 - Arica 4 (F187)	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Sub-national, Madagascar
1804 - SCRID 091-38-4-3-4-1-1-5 (F188)	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Sub-national, Madagascar
1805 - SCRID 220-2-3-3-5-3-4 (F189)	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Sub-national, Madagascar

1806 - Les Maladies Bacteriennes du Riz	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Sub-national, Madagascar
1807 - ASI thresher for reducing postharvest loss	Other	Stage 4: uptake by next user (USE)	Regional, Sub-Saharan Africa
1813 - Perennial rice: improving input efficiency for sustainable rice landscape in Côte d'Ivoire	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Côte d
1815 - High yielding rice variety SEBERI 1 for irrigated lowland rice production systems	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	Global
1816 - High yielding, aromatic variety SEBERI 4 for irrigated lowland rice production systems	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	Global
1817 - High yielding rice variety SEBERI 2 for irrigated lowland rice production systems	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	Global
1818 - High yielding rice variety SEBERI 3 for irrigated lowland rice production systems	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	Global
1821 - Understanding G x E x M by global characterization of rice array panels	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global

1822 - New hybrids that out-yielded the released hybrid AR051H by 20-47% identified	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	Regional, Sub-Saharan Africa
1823 - Elite upland breeding lines out-yielding NERICA 4 by up to 57% identified	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1825 - Elite irrigated lowland breeding lines which out-yielded ISRIZ-07 and Sahel 108 by up to 47% identified	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1826 - Technical books for extension service and farmers to improve fertility and pest management of upland cropping systems.	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National, Madagascar
1827 - algorithme development for measurement of rice leaf Eh-pH-EC	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1828 - High yielding irrigated lowland breeding lines exceeding Sahel 108 and ISRIZ-07 by up to 36% identified in replicated yield trials	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1829 - Sampling methods for assessing intra- and inter-genetic diversity in O. glaberrima, O. sativa and O. barthii compared	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global

1830 - Revised mini-core collection of 350 O. glaberrima accessions that captured 97% of the SNP polymorphism and most of the observed genetic variation, created	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1831 - Superior irrigated lowland breeding lines with yield advantages of up to 22% identified in observational yield trials	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1833 - 21 NILs with introgression of 11 different blast resistance genes	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1834 - Introgression lines for additional partial resistance genes for blast.	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1835 - Lowland breeding lines with Pup1 introgression and improved yield under low-input (P deficient) conditions	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	National, Madagascar
1836 - Upland breeding lines with improved yield under low-input (P deficient) conditions in Madagascar	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	National, Madagascar
1837 - Genomic Selection model to predict grain Zn concentrations	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	Global

1839 - Nutritious rice combining high Zn content and high yield identified in preliminary yield trial	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1840 - Superior irrigated lowland breeding lines identified in multi-location trials in Cote d'Ivoire, Nigeria and Senegal	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1841 - Salt tolerant lines with surface root QTLs introgressed in IR64 background	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1844 - A new variety with high yield is released in Madagascar for irrigated ecology (FOFIFA 188)	Genetic (varieties and breeds)	Stage 4: uptake by next user (USE)	National, Madagascar
1845 - New plant types possessing as many as 10 QTLs identified after profiling with 30 trait-based SNPs	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1846 - A new variety with high yield is released in Madagascar for irrigated ecology (FOFIFA 189)	Genetic (varieties and breeds)	Stage 4: uptake by next user (USE)	National, Madagascar
1847 - A new variety with high yield is released in Madagascar for irrigated ecology (FOFIFA 190)	Genetic (varieties and breeds)	Stage 4: uptake by next user (USE)	National, Madagascar
1848 - New red rice candidate breeding lines are	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end	National, Madagascar

available for release.		of research phase)	
1849 - Cold tolerant and flood tolerant breeding lines are under national evaluation for release	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Madagascar
1850 - Verification of F1 progenies to advance only successful crosses for all ecologies	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Sub-Saharan Africa
1852 - MRV Toolbox for GHG calculation in rice production compiled	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	National, Viet Nam
1858 - AutoMon-An IoT based irrigation advisory service in the Philippines	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Philippines (the)
1860 - Direct seeding equipment for rice	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, South-Eastern Asia
1861 - E-learning course on laser land leveling	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1864 - Diversified and intensified rice-based cropping systems in the southern coastal zone of Bangladesh	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Bangladesh

1871 - Cold tolerant and nutritious red rice lines are identified for Madagascar Highlands	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Madagascar
1890 - A novel NIR-image segmentation method for the precise estimation of above-ground biomass in rice crops.	Research and Communication Methodologies and Tools	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1891 - An unmanned aerial vehicle (UAV) technology for estimating leaf N content in rice crops, from multispectral imagery	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1893 - Selection of 6 lines from the RP for breeding pipelines	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1895 - blast pathogens characterization in Colombia	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Colombia
1913 - Salinity tolerant Variety IR15T1030 (NSICRc 608)	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National, Philippines (the)
1914 - Salinity tolerant Variety IR15T1094 (NSICRc 610)	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National, Philippines (the)
1915 - Salinity tolerant Variety (NSICRc 606)	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National, Philippines (the)

1916 - Drought tolerant variety NSICRc 602	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National, Philippines (the)
1922 - Phenoi software to analyse drone and satellite images	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Global
1923 - Comparative transcriptomics and co-expression networks reveal tissue- and genotype-specific responses of qDTYs to reproductive-stage drought stress in rice	Other	Stage 3: available/ ready for uptake (AV)	Global
1924 - Native trait deployment lines	Genetic (varieties and breeds)	Stage 4: uptake by next user (USE)	Global
1925 - Improved mid-density genotyping platforms for breeding and mapping	Other	Stage 4: uptake by next user (USE)	Global
1926 - QTL profiles	Other	Stage 4: uptake by next user (USE)	Global
1927 - Trait development pipeline	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1928 - NOISYmputer, an algorithm for imputation of low-depth sequencing data in bi-parental populations of diploid species	Research and Communication Methodologies and Tools	Stage 2: successful piloting (PIL - end of piloting phase)	Global

1929 - Characterization of the rice microbial community in YuanYang terraces	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Western Asia
1930 - Knowledge on population structure of the blast fungus in Africa	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Regional, Sub-Saharan Africa
1943 - A fast, efficient and high-throughput procedure involving laser microdissection and RT droplet digital PCR for tissue-specific expression profiling of rice roots	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1945 - Promising lines were released for irrigated lowland conditions in Bangladesh	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	Sub-national, Bangladesh
1953 - OneRice breeding strategy	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Global
1960 - Reinventing Rice Breeding: One pipeline: Two systems	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
2014 - Lowering the glycemic index	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global

2028 - Improving the appearance quality by reducing percent chalk through identification of genetic regions and identifying breeding lines possessing superior haplotypes.	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Philippines (the)
2029 - Reducing the kernel breakage (head rice yield HRY)	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
2109 - Entries from the Antenna and Reference Panels selected for use in breeding pipelines	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Western Africa

Table 5: Summary of status of Planned Outcomes and Milestones (Sphere of Influence-Control)

FP	FP Outcomes 2022	Sub-IDOs	Summary narrative on progress against each FP outcome this year.	Milestone	2020 milestones status	Brief Explanation Provide evidence for completed milestones (refer back to means of verification, and link to evidence wherever possible) or explanation for extended, cancelled or changed	Link to evidence
F1	F1 Outcome: Foresight analyses and priority setting used by RICE and partner scientists to develop and target technology options	• Increased capacity for innovations in partner research organizations	IRRI, AfricaRice and CIAT actively contributed to the activities and publications of the CGIAR Foresight Team, including the development of the CGIAR Foresight Report, and the Future of X that provides perspectives on food security, land and water systems in developing countries. Based on studies on the Rice Tarification Law in the Philippines, the IRRI foresight team proposed policy measures that the Philippine government can use to help rice farmers to adapt and develop profitable businesses. AfricaRice provided policy support to regional initiatives through the development of: (1) Rice Offensive Strategic Plan 2020-2025 and (2) the UEMOA Rice Agenda 2021-2030.	2020 - Operational system with up to date global and regional rice market analysis	Complete	The IRRI Global Rice Model (IGRM) has been upgraded and can be easily integrated into other existing cereal-based models and platforms for global simulations. The update model was used to examine scenarios related to the Rice Tarification Law in the Philippines. The Domestic and international impacts of the rice trade policy reform was studied and findings have been published in Food Policy. An ex-ante assessment of the economic and environmental performances of the rice value chain in 3 West Africa countries (Ghana, Mali and Cote d'Ivoire) for the period 2020-2030. The aim is to identify policy options that can potentially induce pro-poor, sustainable development of the value chain. The estimation of the carbon balance and carbon footprint for both scenarios is used to assess the climate change mitigation impact, while the economic performance of the value chain for both current and upgraded scenario is	https://www.sciencedirect.com/science/article/abs/pii/S0306919220300786

						evaluated based on the income generated, value added and jobs created.	
	F1 Outcome: Improved role in decision making by women and youth in rice value chains as evidenced by empowerment measures at key action sites	• Optimized consumption of diverse nutrient-rich foods	Most seed system interventions by RD organizations may reach women. However, seed systems per se do not directly lead to women's empowerment and gender equality. To achieve this, seed system interventions require specific and targeted objectives, such as the promotion of women's access to resources; women's voice in household and community decision-making; and addressing structural barriers to women's participation. Gender equality and the recognition and leadership of women's involvement in seed management and production not only contribute to women gaining access to quality seeds but also offer important opportunities for them to obtain benefits and also experience empowerment outcomes.	2020 - Learning from effective business models synthesized and communicated	Complete	On 28 March 2018, The Technical Centre for Agricultural and Rural Co-operation (CTA), together with the Africa Rice Center (AfricaRice) and the Syngenta Foundation for Sustainable Agriculture, launched a new project "Promoting youth entrepreneurship and job creation in the West African rice value chain" that will foster youth entrepreneurship, strengthen market ties, and enhance livelihoods in the rice sectors of Mali and Senegal. More than 200 youth individuals and youth groups were selected, and trained on entrepreneurship, management, production, mechanized service provision, processing and marketing of rice. A total of 78 youth groups benefited from on rice value chain and 25 extension agents were trained on Weed Management in rice production. The project impacts as well as the learning from the business model were summarized on the final project report. Impact studies and capitalization of achievements have been carried out to communicate the project results in 2020.	https://www.africarice.org/post/building-capacity-of-youth-in-rice-entrepreneurship-brings-new-hope-to-senegal" style="font-size: 0.98em; background-color: rgb(255, 255, 255); (https://www.africarice.org/post/building-capacity-of-youth-in-rice-entrepreneurship-brings-new-hope-to-senegal) https://www.africarice.org/post/innovations-in-rice-value-chains-offer-increased-job-opportunities-for-rural-youth https://cgspace.cgiar.org/bitstream/handle/10568/110487/h4-pejeriz-completion-report.pdf https://www.cta.int/en/project/promoting-youth-entrepreneurship-and-job-creation-in-the-west-african-rice-value-chain-pejeriz-sid05e536229-5732-44e4-ba7c-

							4a4f76e8897b
	F1 Outcome: Collective innovation and seed systems	• Increased capacity for innovation in partner development organizations and in poor and vulnerable communities	Despite the restrictions imposed by the covid-19 pandemic, some major progress was made toward this outcome. Several activities were implemented to strengthen the seed delivery system. Some activities planned under CoA 1.3 "Collective innovation and seed systems" could not be implemented due to travel restrictions.	2020 extended to 2022 - Sufficient improved seed produced by the seed system to provide seeds for at least 15 million farmers, of which at least 50% are women, at the key action sites	Complete	Against a target of 2,400 head-to-head trials for this reporting year 2020, the Odisha project successfully established 2,404 in 81 blocks spread across 23 districts. Women farmers managed 32% of these trials. Cluster demonstrations were conducted in 81 blocks of 24 districts, engaging 14,426 farmers. A total of 17 varietal cafeteria were established at several sites representative of different rice growing environments. A total of 155 farmers produced 226 tons of Sahbhagi seeds on 75.4 ha in Odisha. Stress-tolerant rice varieties (STRV) have been demonstrated on more than 20,000 ha and more than 80,000 tons of rice has been produced to be used as grain or seed. Cluster demonstrations covered 18,000 ha. A conservative estimate of 10% of the rice produced from these demos is being used/reused as seed, indicating that 7,000 tons of seed has been shared or used in farmer-managed systems. More than 10 new, released, or pipeline STRVs have been tested through 12,800 on-farm trials organized across diverse environments. A total of 67 varietal cafeterias hosted across Odisha engaged and linked nearly 1,500 key stakeholders, including farmers, private seed suppliers, the state seed corporation, input dealers, extension agencies, NGOs, and government as well as researchers.	www.grisp.net http://books.irri.org/Odisha-Annual-Report-2019-2020.pdf

	F1 Outcome: Effective networks and mechanisms to provide policy makers with up-to-date and evidence-based information on the rice sector	• Enhanced individual capacity in partner research organizations through training and exchange • Increase capacity of beneficiaries to adopt research outputs	Based on two studies on the Rice Tarification Law in the Philippines, IRRI proposed policy measures that the Philippine government can use to help rice farmers to adapt and develop profitable business in agriculture or outside, particularly those who are negatively impacted by the reform. In India, IRRI creatively engaged with various stakeholders in Bihar, Odisha and Assam. IRRI responded proactively to the request from the government of Assam and prepared a rice strategy for the state. With foresight analysis, AfricaRice contributed to two regional initiatives: (1) Rice Offensive Strategic Plan 2020-2025 and (2) the UEMOA Rice Agenda 2021-2030	2020 - At least 2 agrifood policies informed by recommendation from rice science are adopted in Asia, Africa and Latin America and Carribean	Complete	Faced with high domestic rice prices that have fueled inflation above the 2018 target and penalized poor consumers the most, the government of the Philippines has decided to abandon the quantitative restrictions on imports and replace them with tariffs. Results from the IRRI study suggest that the reform would increase imports by 2.47 million tons (20.7%) in 2019. The study also found a large decline in farm prices and retail prices respectively by PhP (Philippine peso) 6.1/kg (30.1%) and PhP 7.6/kg (17.4%) in 2019 that explains an increase in rice consumption. The study shows a slight increase in world prices, which led to small increases in the domestic prices of South and Southeast Asian rice markets. While this reform is largely pro-poor consumers, policy makers would need to use the additional tariff revenue to help rice growers either increase their competitiveness and modernize their rice production or shift to other crops.	https://www.sciencedirect.com/science/article/abs/pii/S0306919220300786 https://riceforafrica.net/meetings-page/regional-workshop/ecowas/ecowas-meeting,-feb-2020 http://www.hubrural.org/PREMIERE-REUNION-DU-GROUPE-DE-TRAVAIL-POUR-L-ELABORATION-DE-L-AGENDA-RIZ-DE-L.html?lang=fr
				2020 extended to 2021 - 250-300 scholars (30% women) enrolled in advanced degree training (bachelors, masters, PhD)	Extended	The advanced degree training is a continuous milestone	www.grisp.net

	F1 Outcome: Originally: Effective seed delivery systems - this outcome was merged with Innovation systems in 2018	• Increase capacity of beneficiaries to adopt research outputs		2020 extended to 2022 - Moved to Outcome Innovation Systems in 2018: Sufficient commercial seed produced by the seed system to provide seeds for at least 15 million farmers, of which at least 50% are women, at the key action sites	Extended	In the reporting year of 2019-20, employing different approaches, a range of suitable varieties was tested across the state in close coordination with key stakeholders in the seed system. This was accomplished through strategic engagement with local NGOs, input dealers, and various government departments, which facilitated the process of Stress-tolerant rice varieties (STRV) and high-yielding varieties popularization, seed production, and distribution. In addition, through various capacity-building programs, the adoption of good-quality seed production practices by farmers was enhanced. STRV awareness programs were organized for 82,000 farmers. The formal seed system has been strengthened by advancing several new varieties and infusing 74 quintals of breeder seed for further multiplication. A total of 398 master trainers and 11,230 farmers have been trained in good-quality seed production. A total of 32,880 minikits were provided through dealer networks to create demand for new products.	http://books.irri.org/Odisha-Annual-Report-2019-2020.pdf
	F1 Outcome: Impacts and adoption of RICE technologies assessed and		Several studies adoption and impact and studies were conducted and published in peer-reviewed journals: dissemination and adoption of bundled agronomic practices; Economic surplus analysis of IRRI's contributions to rice	2020 - impact assessed of adoption of improved rice varieties in Asia, Africa and latin	Complete	A study at IRRI demonstrated that a 10% increase in the genetic contribution of IRG accessions to an improved rice variety is associated with a yield increase of 27%. IRRI also implemented a large scale RCT to understand the impact of psychological	https://ageconsearch.umn.edu/record/295793/files/243 https://link.springer.com/article/10.1007/s12571-020-01036-9 https://doi.org/10.1016/j.

	published		varietal yield changes in Bangladesh over the 1990-2018 period; The contribution of the International Rice Genebank to varietal improvement and crop productivity in Eastern India; Impact assessment of the contribution of the Coalition for Africa Rice Development (CARD) to rice production in 23 countries, and of adoption of personalized extension advice, ASI credit, rice variety ARICA 6, iron toxicity-tolerant varieties, and drought-tolerant varieties in Benin, Nigeria and Madagascar.	America		interventions on economic decisions in agriculture. AfricaRice showed that the contribution of CARD to paddy production in 2018 was 10.2 million tons, equivalent to 74% of target. Impact assessment of personalized extension advice shows that households who received the personalized advice increased yield by 7% and profit by 10%. Impact Assessment of ASI credit required show that ASI rice thresher adopters borrowed more money in comparison to their neighbors who had not adopted the ASI thresher. Impact assessment of ARICA 6 shows a positive impact on yield, net income and technical efficiency. Impact assessment of Drought tolerant rice varieties in Benin, Nigeria and Madagascar: show positive impacts on Yield, Income and Food Security. It has also decreased the food expenditure. CIAT conducted a qualitative assessment of COVID-19 in the rice value chain. A report was distributed across diverse rice actors and two special regional seminars were organized to discuss the conditions of rice production in the LAC region.	wdp.2021.100291 https://ssrn.com/abstract=3684527 https://onlinelibrary.wiley.com/doi/10.1111/ajae.12151 https://www.tandfonline.com/doi/full/10.1080/20421338.2020.1855746 https://doi.org/10.4060/cb1659en https://doi.org/10.4060/cb1504fr https://doi.org/10.4060/cb1506fr https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3592455
	F1 Outcome: Functional and effective results-based management system for RICE	• Increased capacity for innovations in partner research organizations	The Rice Observatory that is oriented to compile and showcase most of the information collected throughout CIAT research activities. The initiative aims to continue expanding its geographic reach and areas of analysis. At AfricaRice, the e-registration of rice	2020 - RICE workshop "Monitoring Evaluation Learning Impact Assessment and Gender" held to guide and adjust	Complete	The RICE workshop "Monitoring Evaluation Learning Impact Assessment and Gender" could not held physically in 2020. However the FP 1 annual workshop was held virtually on October 21 and 22, 2020. There were participants from three centers (IRRI, AfricaRice and CIAT), 36 in total. The main	www.grisp.net

	and its partners		value chain actors in Benin and Côte d'Ivoire was established for assessing the adoption of innovations and the diffusion of new rice technologies. The implementation of the Impact-Oriented Monitoring and Evaluation (IOMEL) strategy was constrained by the covid-19 pandemic. Several activities were postponed to 2021, in particular the capacity development trainings on IOMEL and impact culture.	RICE work plan		objective of the meeting was to take stock of achievement in 2020 and present the planned activities and studies for 2021. The three centers presented in 4 sessions: Foresight and Targeting; Adoption and Impact Assessment; Monitoring, Evaluation, Accountability and Learnings; Gender and Youth. Although the workshop was attended by FP 1 members only, it did offer the opportunity to guide and adjust RICE work plan. The workshop report is available on www.grisp.net	
F2	F2 Outcome: Diversified enterprise opportunities through upgraded value chains at six action sites (Indonesia, Myanmar, Vietnam; Cote d'Ivoire, Nigeria, Tanzania)	• Diversified enterprise opportunities	CIRAD, AfricaRice and IRRI assessed the state of rice value chain upgrading in 15 West African countries, which can assist the Coalition for African Rice Development (CARD), value chain actors and policymakers in refining upgrading strategies and policies. AfricaRice initiated rice value chain upgrading studies in Nigeria and Benin, generating opportunities for value chain actors, such as increased efficiency and access to new markets and industry knowledge. IRRI published a book on sustainable rice straw management covering several countries, which can guide policy makers in South and Southeast Asia in their strategies to reduce greenhouse gas emissions and air pollution.	2020 - Upgrading strategies piloted with partners for verification in three action sites	Complete	The state of rice value chain upgrading together with a follow-up paper on COVID-19 policy options was published in Global Food Security. A market study on NERICA rice varieties in Uganda was published in Outlook on Agriculture and a consumer study on rice fragrance in 37 cities across seven countries (Bangladesh, India, Cambodia, Indonesia, the Philippines, Thailand, and Vietnam) in British Food Journal. Progress with rice value chain upgrading in Nigeria and Benin was captured in annual and technical reports: AfricaRice, 2020. Upgrading the rice value chain in Nigeria for competitive markets. In: Africa Rice Center (AfricaRice) Annual Report 2019: Toward rice-based food systems transformation in Africa. Abidjan, Côte d'Ivoire: Africa Rice Center, page 12; 2020 Annual Report on the Project "Applying Innovation System Approach in	https://doi.org/10.1016/j.gfs.2020.100365 https://doi.org/10.1016/j.gfs.2020.100405 https://doi.org/10.1177%2F0030727020948967 https://doi.org/10.1108/BFJ-01-2019-0025 https://43c018b3-2e2d-4407-af86-1d6495506405.filesusr.com/ugd/0839e4_8286da451fa44272ba9f8c91f3a946db.pdf https://cgiar-my.sharepoint.com/:b:/g/personal/s_ndindeng_cgiar_org/Efl7iTiIzqZNn8vpEsKRqJMBhc0S5KRFLVEyLaO2XywU-Q?e=RhIwde https://cgiar-my.sharepoint.com/:b:/g/

						Rice Value Chain Analysis and Development for Competitive Markets in Nigeria"; Fiamohe R., Dedehouanou S. F.A., 2021. Improving local rice market performance and consumers' welfare through the usage of branded and labelled packaging in Benin. Technical report, January 16, 2021. University of Abomey Calavi (UAC), Benin; IRRI's book on rice straw management was published by Springer and features 11 studies, covering various aspects of the use of rice straw to reduce greenhouse gas emissions.	personal/s_ndindeng_cgiar_org/ESozhGP_sx5Nu0CJlo2i1LgBVjx9gPcScSycbt30i4MBvQ?e=8TXjhF https://doi.org/10.1007/978-3-030-32373-8
	F2 Outcome: Income by value-chain actors increased by 10% at six action sites through improved access to financial and other services (Indonesia, Myanmar, Vietnam; Cote d'Ivoire, Nigeria, Tanzania)	• Improved access to financial and other services	Due to donor priorities, activities in Africa shifted to other countries than initially planned. Significant progress was made, thanks to innovation platforms centered around technology upgrading: 1. Innovation platforms in Nigeria successfully connected rice value chain stakeholders to microfinance institutions, generating substantial income increases; 2. The Glazoue Rice Innovation Platform in Benin set up around the GEM parboiling facility in 2015 was able to access substantial financial credit; 3. CEMAs (Mechanized Service Centers) provide mechanized and digital services to producers have attracted sizeable funding and generated substantial income increases of rural	2020 extended to 2021 - Value chains upgraded at three action sites; upgrading strategy expanded with lessons captured in three additional action sites	Complete	Since its establishment, the Goronyo innovation platform has generated US$ 3,800 revenue and US$584 profit in Nigeria. The Bukan-Sidi-Lafia Rice Innovation Platform set up around the GEM parboiling facility in 2016 generated over US$ 181,800 and raised US$ 13,130 among its membership. Within a month, the platform generated over US$ 53,968 through service provision and sale of quality domestic parboiled rice from the new rice mill, with 16 women and 7 men employees. The PEJERIZ project enabled a 23.7% increase in the annual income of rural youth involved in innovative rice development models along the rice value chain in Mali and Senegal. The CEMAs (Mechanized Service Centers), which provide mechanized and digital services to producers, have seen their funding multiplied by 3.5 for Senegal (from EUR	https://43c018b3-2e2d-4407-af86-1d6495506405.filesusr.com/ugd/0839e4_8286da451fa44272ba9f8c91f3a946db.pdf https://cgiar-my.sharepoint.com/:b:/g/personal/s_ndindeng_cgiar_org/Efl7iTiIzqZNn8vpEsKRqJMBhc0S5KRFLVEyLaO2XywU-Q?e=RhIwde https://cgiar-my.sharepoint.com/:w:/g/personal/s_ndindeng_cgiar_org/EfBGmUk9BBlArq9jJGNJohgB4k9g5zzEHCKnPcD8QMyJ-g?e=xtn2hh https://cgspace.cgiar.org/bitstream/ha

			youth in Mali and Senegal.			125,770 to EUR 435,187). The CEMAs of Mali received for the first time substantial financing for EUR 126,228. In Benin, the Glazoue Rice Innovation Platform attracted a total credit of US$ 380,164 between 2017 and 2020.	ndle/10568/110487/h4-pejeriz-completion-report.pdf https://doi.org/10.1016/j.gfs.2020.100365 https://cgiar-my.sharepoint.com/:v:/g/personal/s_ndindeng_cgiar_org/EeBjGAijpq1AmrP_BI4IOAEBm6gyGpAQ28xsxT8hL6ALHg?e=xbxj4r (15 min 13 sec to 16 min 45 sec in of the video)
	F2 Outcome: Income by value-chain actors increased by 15% through adoption of at least one of the postharvest or value addition practices or technologies at six action sites (Bangladesh, Cambodia, Indonesia; Benin, Cote d'Ivoire, Nigeria)	• Reduce pre- and post-harvest losses, including those caused by climate change	IRRI conducted research on post-harvest losses and carbon footprint in intensive lowland rice production in Myanmar. Despite using additional energy for machine manufacturing and fuel consumption, the mechanized practices significantly reduced postharvest losses. AfricaRice established a processing facility for the Goronyo Rice Innovation Platform, including ASI thresher-cleaner, Satake SB10 mill, destoner, rice grader, GEM and mini-GEM parboiling equipment, drying and storage space. The Glazoue Rice Innovation Platform set up around the GEM parboiling facility in 2015 in Benin has made significant progress in upgrading along the value chain trajectory.	2020 extended to 2021 - Upgrading strategies to reduce pre-and post-harvest losses piloted with partners for verification in three action sites	Complete	IRRI published research findings in Scientific Reports on post-harvest losses and carbon footprint in Myanmar. The article demonstrates that mechanized practices increased net income by 30-50% compared with traditional practices. Despite using additional energy for machine manufacturing and fuel consumption, the mechanized practices significantly reduced postharvest losses and did not increase the total life-cycle energy and greenhouse gas emissions. Reducing rice postharvest losses is one of the major achievements of the Vietnam Sustainable Agriculture Transformation Project (VnSAT), 2017-2020. IRRI's contribution over the past 4 years has helped increase the productivity and profitability of Vietnam's farmer associations" said MARD Deputy Minister Dr. Le Quoc Doanh in 15 Dec 2020. The information is featured in a news article.	https://www.nature.com/articles/s41598-020-76639-5 https://www.irri.org/news-and-events/news/vietnam-thanks-irri-contribution-vnsat-increasing-rice-productivity-and-income;https://vietnamnews.vn/society/829491/sustainable-agriculture-projects-raises-farmers-profits-and-production.html https://43c018b3-2e2d-4407-af86-1d6495506405.filesusr.com/ugd/0839e4_8286da451fa44272ba9f8c91f3a946db.pdf https://cgiar-

						Since its establishment, the Goronyo Rice Innovation Platform has processed around 23 tons of paddy each month, generating US$ 3,800 revenue and US$ 584 profit. A complete switch from wood to rice husk as fuel has saved an estimated $30–40 per ton of rice that would otherwise be spent on wood. In Benin, the Glazoue Rice Innovation Platform set up around the GEM parboiling facility has made significant upgrading along the value chain trajectory. The progress is captured in annual reports and a video.	my.sharepoint.com/:b:/g/personal/s_ndindeng_cgiar_org/Efl7iTiIzqZNn8vpEsKRqJMBhc0S5KRFLVEyLaO2XywU-Q?e=RhIwde https://cgiar-my.sharepoint.com/:v:/g/personal/s_ndindeng_cgiar_org/EeBjGAijpq1AmrP_Bl4IOAEBm6gyGpAQ28xsxT8hL6ALHg?e=xbxj4r (15 min 13 sec to 16 min 45 sec in of the video)
	F2 Outcome: Functional value chains for improved processing and novel products from rice at six action sites (Bangladesh, Cambodia, Indonesia; Benin, Cote d'Ivoire, Nigeria)	• Increased value capture by producers	IRRI published a book reporting on rice by-product development in several countries and a database capturing the diversity of food choice in India, which can help value chain actors introduce novel products in Indian diets. AfricaRice demonstrated the methodology for the production of fortified and non-fortified rice-based products, which can be a reliable vehicle for delivering micronutrients to vulnerable populations. JIRCAS' plan to visit AfricaRice to check pilot-scale pop-rice equipment was cancelled due to covid-19 related travel bans. JIRCAS concentrated only physicochemical analysis of pop-rice starch and their Thai partners conducted product	2020 extended to 2021 - Upgrading strategies to increase value captured by actors piloted with partners for verification in three action sites	Complete	Although good progress was made by IRRI and AfricaRice, JIRCAS had to move some deliverables to 2021 due to covid-19 related restrictions. IRRI's book on rice straw management features several reports on successful rice by-product development in multiple countries in Asia. A database of Indian diets, which can be used for product development and value addition to products by value chain actors was published in the International Journal of Gastronomy and Food Science and Data in Brief. AfricaRice's study on fortified and non-fortified rice-based products was published in Food Science and Nutrition.	https://doi.org/10.1016/j.ijgfs.2020.100249 https://doi.org/10.1016/j.dib.2020.106330 https://driversoffoodchoice.org/wp-content/uploads/2020/09/Demont.pdf https://doi.org/10.1002/fsn3.1622 https://doi.org/10.1007/978-3-030-32373-8

			development for pop-rice.				
F3	F3 Outcome: Improved management practices that reduce yield gap by 10-15% developed and disseminated at eight action sites (Nigeria, Senegal, Tanzania, Madagascar, Vietnam, Indonesia, Bangladesh, Myanmar)	• Closed yield gaps through improved agronomic and animal husbandry practices	The Sustainable Rice Platform (SRP) was promoted in Vietnam through a field demonstration (13 ha) combining 'Small Farmers - Large Field model', 1M5R management practices, and SRP guidelines. This generated evidence of impact of 1M5R and mechanized transplanting such as: yield and net income increased by 5-10,; reduced seed rate by 40-60%, reduced pesticide application by 30-40%, and reduced greenhouse gases by 30%. The decision support system RiceAdvice was disseminated to 14,900 farmers in Nigeria and Senegal. In Rwanda, 45 demonstration plots were established to disseminate good agricultural practices and 1,080 rice farmers were trained though farmer field days.	2020 - Potential adoption of improved practices by the women and poor assessed, and strategies developed for enhancing their adoption rate	Complete	IRRI: Reasons for poor adoption of Alternate Wetting and Drying in Bangladesh were identified and a paper was published. Factors influencing the acceptance of sustainable farming practices in the Mekong river Delta of Vietnam identified. AfricaRice: Impact of Smart-valley approach for adaptation to climate change in rice production system was assessed in four countries of sub-Saharan Africa. Papers on impact assessment of the decision-support system RiceAdvice were published. Strategies for enhancing adoption were identified. AfricaRice investigated the adoption of good agricultural practices (GAP, disseminated to farmers in the Highlands in Madagascar, and identified key constraints to scaling of GAPs. CIAT: CIAT reported that irrigation combined with smart crop management practices allowed small-/medium-scale farmers to increase their yields of rice, maize, beans, and high-value crops by two to four times in comparison with historical yields obtained under rainfed conditions. Scaling of this innovation requires development of local capacity. JIRCAS: Scaling approach for the decision-support system WeRise was taken for the Philippines and Indonesia. A short video was released on FACEBOOK and site-specific nutrient management for increasing the potential adoption of the tool to wider	IRRI https://drive.google.com/drive/u/0/search?q=SRP%20OS https://doi.org/10.3390/w12051510 https://doi.org/10.1016/j.wdp.2020.100204 https://doi.org/10.3362/1755-1986.20-00007 AfricaRice https://onlinelibrary.wiley.com/doi/full/10.1111/ajae.12151 https://www.tandfonline.com/doi/abs/10.1080/09614524.2020.1770699 https://grispnetwork.group site.com/files/1017109/preview https://www.africarice.org/post/malagasy-women-farmers-continue-to-champion-good-agricultural-practices CIAT https://www.frontiersin.org/articles/10.3389/fsufs.2020.437086/full JIRCAS https://doi.org/10.20710/dohikouen.64.0_99_2 https://doi.org/10.1007/s11104-018-3869-1 https://www.facebook.com/342074396877/vide

						beneficiaries. During 2020, the access of WeRise was increased and a total of 1,650 access was identified.	os/2590101137986089
	F3 Outcome: Improved management practices that increase input use efficiency by 5% developed and disseminated at eight action sites (Nigeria, Senegal, Tanzania, Madagascar, Vietnam, Indonesia, Bangladesh, Myanmar)	• More efficient use of inputs • Enhanced conservation of habitats and resources • More productive and equitable management of natural resources	Promising site-specific nutrient management practices were identified in Rwanda, Senegal, and Tanzania. Impact of AWD on yield, water productivity, and weeds were quantified in Côte d'Ivoire. A pilot project with a private company in Panama was launched in 2020 to increase productivity and reducing production costs. Results from the first demonstration plots showed average production cost was reduced by 22% and profitability was doubled as compared to conventional management.	2020 - Male and female farmers participating in demonstration increase input use efficiency by 5% at six action sites	Complete	IRRI: An IoT based irrigation advisory service (AutoMonPH) decision that entails efficient water management, continuous monitoring, reporting and verification of water management practices, and a multi-stakeholder interface was developed and piloted in the Philippines. AfricaRice: Promising site-specific nutrient management practices were identified for Rwanda and Tanzania. Alternate Wetting and Drying could reduce weed biomass by 36%, water input by 52% and increase water productivity by 20% without affecting rice yield and grain quality. Salinity management using improved management options can increase yield by 0.6 to 2.5 t/ha. CIAT: In Uruguay, improved management practices increased profitability by 7.6% as compared with conventional management, whereas there was no yield difference between two management practices. This increase is mainly due to the use of less seed and less nitrogen per area unit. JIRCAS: A partnership project of JIRCAS identified that fertilizer use efficiency for lowland rice production can be improved by dipping rice seedlings into P-enriched slurry at transplanting under P-deficient lowlands in Madagascar.	IRRI https://drive.google.com/file/d/1wmXCe724XdgDgoHoS0_19i6NWybnLoEY/view?usp=sharing AfricaRice https://onlinelibrary.wiley.com/doi/full/10.1111/jac.12420 https://onlinelibrary.wiley.com/doi/full/10.1111/aje.12151 https://www.tandfonline.com/doi/abs/10.1080/09614524.2020.1770699 CIAT https://www.facebook.com/watch/?v=595097444544949 https://www.youtube.com/watch?v=0dfkYbs0zj0 https://www.ande.org.uy/beneficiarios/item/fortalecimiento-de-las-estrategias-de-transferencia-para-reducir-las-brechas-de-rendimientos-en-el-sector-arrocero.html http://aca.com.uy/wp-

							content/uploads/2019/11/Arroz99.pdf https://www.youtube.com/watch?v=XM6zCliBtU4 JIRCAS https://doi.org/10.1016/j.fcr.2020.107806
	F3 Outcome: Options to diversity rice farms with other crops, animals, or trees developed and disseminated at six action sites (Cote d?Ivoire, Madagascar, Tanzania, India, Bangladesh, Myanmar) (together with other CRPs)	• Increased livelihood opportunities	6-yr experiments on assessing productivity and resilience of upland-rice based systems were completed in AfricaRice Mbe station, Côte d'Ivoire. In Burkina-Faso, on farm trials on lowland rice system showed (i) a high carry-over effect of potatoes rotation with rice for soil fertility; and (ii) a good profitability (return on investment) of low dose urea land-filling at sowing for rice subject to floods. Crop diversification options were jointly tested with farmers in Cote d'Ivoire, Madagascar, Senegal, and promising options were identified together with farmers.	2020 - Out- and up-scaling approaches for diversification options identified at four action sites	Complete	IRRI: Results of field study conducted for three years (2016–2019) in Polder 30 in Bangladesh identified promising cropping systems with improved varieties. AfricaRice: The documents describing scaling approach for diversification options for upland rice-based systems in Côte d'Ivoire and lowland rice for Senegal are available. CIAT: The FLAR's (Latin-America foundation for irrigated rice) Rice/Soybean Rotation Project with the objective of validating the adaptation of soybean cultivars and establishing agronomic management practices for rotation systems with rice in the tropical zone of Latin America and the Caribbean. As a result of this project, Nicaragua, through its Rice Farmers Association, is facilitating the registration and seed commercialization, by a private company, of at least one soybean variety introduced by FLAR from Brazil. Same result was obtained in Colombia, where the National Rice Farmers association facilitated the registration and multiplication of two soybean varieties introduced by FLAR. In Venezuela, soybean became the most valuable alternative for rotation with rice, as	IRRI https://doi.org/10.1016/j.agsy.2020.102986. AfricaRice https://grispnetwork.groupsite.com/files/1018637 https://grispnetwork.groupsite.com/files/1018636 Groot et al. Exploring opportunities for diversification of smallholders' rice-based farming systems in the Senegal River Valley. Agri. Sys. under review (mid-Mar 2021) CIAT http://www.iniap.gob.ec/pruebav3/especialistas-del-fondo-latinoamericano-para-la-produccion-de-arroz-bajo-riego-flar-visitaron-ecuador/ https://www.sica.int/consulta/Noticia.aspx?Idn=103501&idm=1 https://danac.org.ve/pres

						a consequence on this project. CIRAD: In Madagascar for low-input rice based cropping systems, technical books were developed for distribution to extension service and farmers to improve fertility and pest management of upland cropping systems.	s/2016/08/08/fundacion-danac-2016-2/ https://www.elimpulso.com/2018/06/28/agricultores-interesados-en-la-soya-como-buena-alternativa-de-siembra/ http://www.asoportuguesa.org/?p=4008 CIRAD https://www.secure.mg/ https://www.icropm2020.org/
	F3 Outcome: Diversified on-farm diets sourced through diversified farming systems at four action sites (Cote d'Ivoire, Madagascar, Bangladesh, Myanmar) (together with other CRPs)	• Increased access to diverse nutrient-rich foods	On-farm survey for assessing linkage of farm diversification with on-farm diet diversity was completed in Madagascar, Nigeria, Rwanda, and Senegal. Preliminary analysis in Rwanda, Madagascar and Nigeria found positive relationships between diversification and nutritional outcomes. Thus, development and dissemination of crop diversification options including vegetables and legumes might be an effective strategy for diversifying farmers' diets thereby contributing significantly to improved nutrition.	2020 - Potential impact of farm diversification on on-farm diets established at four action sites	Complete	AfricaRice: On-farm survey for assessing linkage of farm diversification with on-farm diet diversity was completed in Madagascar, Nigeria, Rwanda, and Senegal. Among the children up to 5 years of age, severe stunting is noted in Nigeria and Senegal (above 80% of the surveyed households that included young children). In Rwanda, 30% of the surveyed households with children were found to be stunted. While the proportion of severe stunting is higher in female headed and female managed households in Rwanda, in Nigeria and Senegal, this observation is noted for male-headed households. The crop diversification index is high in Madagascar, Nigeria and Rwanda; farmers grow as many as 2 to 3 crops on their farms, male headed households are more diversified than female headed households. In Senegal, farmers are less diversified. Preliminary analysis in Rwanda,	https://grispnetwork.groupsite.com/folders/286086

						Madagascar and Nigeria also found positive relationships between diversification and nutritional outcomes. Thus, development and dissemination of crop diversification options including vegetables and legumes might be an effective strategy for diversifying farmers' diets thereby contributing significantly to improved nutrition. Malnutrition and food insecurity are noted in terms of relying on less preferred foods, limiting the variety of foods eaten, and the size of meal portions.	
	F3 Outcome: Improved rice management practices that reduce GHG by 5% disseminated at three action sites (Bangladesh, Philippines, Vietnam)	• Reduced net greenhouse gas emissions from agriculture, forests and other forms of land-use (More sustainably managed agro-ecosystems) • Reduced net greenhouse gas emissions from agriculture, forests and other forms of land-use (Mitigation and adaptation achieved)	A toolbox has been built consisting of tools, guidelines, and templates to advance the work of monitoring, reporting, and verification of greenhouse gases calculation along the rice value chain. It is provided in form of an accessible and interactive platform which enables users to access the suitable tools/templates/guidelines according to their purposes.	2020 - Climate-smart technologies to reduce GHG emissions tested at climate-smart villages through CCAFS, and scaled out through CCAFS networks	Complete	Updated regional maps of drought and salinity intrusion risks (both for normal and extreme years) for rice production areas in the Mekong River Delta are products of the collaborative work of the Department of Crop Production - Vietnam's Ministry of Agriculture and Rural Development and CCAFS Southeast Asia in 2020. The climate risk maps (CS-MAPS) helped adjusting the cropping calendar along with climate smart technologies in the MRD, Vietnam. Rapid expansion of groundwater use for irrigation for dry season rice production in Bangladesh has led to overuse, deterioration of groundwater quality, increased cost of irrigation, and higher greenhouse gas emissions. The divergence between marginal private and social cost of irrigation due to market failures in the presence of these externalities, has resulted in excessive use of groundwater. A combination of policy	https://ccafs.cgiar.org/resources/publications/regional-climate-smart-maps-and-adaptation-plans-cs-map-mekong-river https://doi.org/10.3390/w12051510

						reforms and improvements in irrigation practices are hence needed to reduce irrigation water use.	
	F3 Outcome: Results of completed farming systems analyses used to focus development activities on key opportunities for adapting to climate risks at eight action sites (Nigeria, Senegal, Tanzania, Madagascar, Vietnam, Indonesia, Bangladesh, Myanmar)	• Enhanced capacity to deal with climatic risks and extremes (Mitigation and adaptation achieved)	In Africa, digital data collection and decision support tool for Sustainable Rice Platform (SRP) standard and performance indicators was developed based on survey solution platform. This tool has been used to collect information on farmers' sustainable rice cultivation level in Ivory Coast, Senegal, Nigeria, and Madagascar in 2020. Using data collected in 2013-2014, five sustainability performance indicators (grain yield, net profit, labor productivity, and N and P use efficiencies) were quantified to benchmark rice production systems in Subs-Sahara Africa.	2020 - A basket of options on climate-smart technologies communicated to national policy framework (with FP1)	Complete	IRRI: A survey was conducted in the Philippines to review the government policies supporting agricultural mechanization and assess the management and utilization of mechanical transplanters including the perception of various stakeholders. The results have been published and shared with The Department of Agriculture-Bureau of Agricultural Research (DA-BAR). AfricaRice: A basket of options on climate-smart technologies were presented in ECOWAS Consultative Meeting on Rice Offensive (West Africa region's Rice Development Strategy) in 4 - 5 Feb, 2020. JIRCAS: The user manual of the decision-support system WeRise was developed (in printing) in collaboration with national partners of Philippines and Indonesia to facilitate climate-smart rice production management.	IRRI Yadav, S., Burac, M. A. E., Dedicatoria, R.M., Regalado, M.J.C., Cabrera E. R., Javier, L.C., Agpalza, Q.J., Clavero, R.R., Galdonez, V. Martin, R., Sandro, J., Bautista, E.G., and Baliè, J. (2020). From Policy to Practice: A closer look at mechanical transplanting in Cagayan Valley (Region II) in the Philippines. Water-efficient and risk mitigation technologies for enhancing rice production in irrigated and rainfed environments Project, International Rice Research Institute, Los Baños, Philippines. 48 pages. AfricaRice https://riceforafrica.net/meetings-page/regional-workshop/ecowas/ecowas-meeting,-feb-2020 https://grispnetwork.groupsite.com/files/1018638 https://www.sciencedirect.com/science/artic

							le/pii/S2452292921000059 JIRCAS https://www.facebook.com/342074396877/videos/2590101137986089
F4	F4 Outcome: Information on the impact of environmental factors (climate, soil, biotic stress) on rice production used to predict global rice production risks and to guide development and deployment of climate smart technologies.	• Enhanced adaptive capacity to climate risks (More sustainably managed agro-ecosystems)	Worldwide field trials were completed for Antenna (AP) and Reference (RP) panels. We received 55 AP datasets (25 locations), 21 RP datasets (11 locations), and location soil/climate data from the global network. Data has been curated; R-scripts shared with partners. Preliminary GWAS was completed, identifying consistent genomic regions for agronomic traits. These results allow understanding GxE, identifying stable germplasm, finding QTLs/genes for rice breeding. 28 AP and 7 RP entries were selected and are now in breeding pipelines of CGIAR centers and NARES partners in India, Vietnam, Burundi, Bangladesh, Senegal, Cote d'Ivoire, Colombia, Uruguay.	2020 extended to 2021 - Preliminary GxE analysis of the first antena data; climatic, soil and pest an disease data used to explain yield variation	Changed	The FP4 CoA 1 outcome above to define GxE factors was not achievable in 2020. We hired a post-doctoral fellow at Cirad who is working on climate, soil and AP data to accomplish this during 2021. This information will be shared with the collaborators the Agricultural Model Inter-comparison Project (AgMIP) from Japan for modeling scenarios. Some trials could not be completed in 2020 and are being done in 2021. All agronomic and yield data collected from the trials has been uploaded in the following website and folders. Field photos of some of the experiments conducted have also been uploaded. Preliminary results have been presented as a poster during the online 25th Federation of Crop Science Society of the Philippines Scientific Conference.	Access granted on request: https://sites.google.com/a/irri.org/demo-fp4-gra/ https://drive.google.com/drive/folders/1M6CABVCwoxYKtBGVyD8isofHPzjLek6j https://drive.google.com/drive/u/0/folders/11FukHgYlQaLuh2E0sbO0p4Exja3S2MAv
	F4 Outcome: A functional global phenotyping network composed of 30% non-CRP partners (including	• Adoption of CGIAR materials with enhanced genetic gains	2019 high-throughput (HTP) data from IRRI and India was processed and compiled. 2020 HTP data at IRRI was limited to the antenna panel for the wet season due to the pandemic, while data was successfully acquired for both	2020 extended to 2021 - Global data from the first reference panel is compiled and a new reference panel is	Changed	High-throughput (HTP) datasets from IRRI and India for 2018-2020 are stored locally at IRRI. It was not possible to collect HTP data for the reference panel (RP) at IRRI in 2020 due to the pandemic. Data is available for the wet seasons of 2018 and 2019 and for	HTP data will be loaded here: https://sites.google.com/a/irri.org/demo-fp4-gra/info-on-panels/data-from-ap-rp-trials and in

	self-sponsored), and genetic donors (>10) and ideotypes (2-4) adopted by breeding programs to develop climate-smart rice varieties		the antenna and the reference panels in India. We currently have three RICE partners and one NARES partner from India using unmanned aerial vehicles for HTP. Two NARES from India dropped their involvement on loss of personnel. An image analysis method to determine biomass and leaf nitrogen content was developed at CIAT. Meteorology and imaging stations were established at AfricaRice sites.	deployed at the HTP sites		the dry season of 2019; an additional trial will be conducted in the dry season of 2021 in order to have four seasons of data from IRRI. Unmanned aerial vehicles were obtained by AfricaRice in 2020, trials are underway at Senegal and Cote d'Ivoire sites. During 2020, two image-analysis trials for HTP on the RP were conducted at CIAT. An IRRI instance of BreedBase (a BrAPI compliment database) accommodating HTP (image) data is now being implemented and will be extended at IRRI in collaboration with Lukas Mueller (Cornell). The API to our BreedBase will include additional analyses tools for machine learning and downstream analyses, e.g. for GWAS and genomic selection/prediction. The web API and database will be hosted at the Philippines Dept. of Science and Technology super-computing facility via an ongoing collaboration.	the BreedBase database & API.
	F4 Outcome: Characterized pathogens populations and diversity used to predict varietal deployment for at least 3 major rice diseases	• Enhanced capacity to deal with climatic risks and extremes (Mitigation and adaptation achieved)	We characterized several pathogen populations, identified effective resistance genes for South Asia, Southeast Asia, and Africa for the diseases Bacterial Leaf Blight (BLB), Blast, Rice Yellow Mottle Virus, and for Brown Spot in West Africa. In addition, we have developed molecular markers to monitor and track BLB, Blast, and Brown Spot populations in the field, allowing across countries. All information is updated in the	2020 - Disease resistance donors and wide spectrum resistance genes for RYMV, Blast, BLS and BLB	Complete	Based on 450 Xanthomonas oryzae genomes collected in Asia, we have developed 40 SNP markers to track Bacterial Leaf Blight populations. Based on 180 Magnaporthe oryzae genomes collected worldwide, we have developed 30 SNP markers to track leaf blast disease. A collection of around 50 Rice Yellow Mottle Virus samples from East Africa are stored at the IRRI hub in Nairobi. Most information is currently integrated into the PathoTracer	Information on Pathotracer can be found at this link: http://webapps.irri.org/pathotracer/ A preprint about blast genomics can be found here: https://www.biorxiv.org/content/10.1101/2020.11.17.377325v1.full The first manuscript on BLB genomes can be found

			PathoTracer tool. Further, the root microbiome of modern varieties was characterized in China. Collections are done by partner institutions; most setbacks stemmed from the pandemic. This has resulted in collection of fewer samples.			platform.	here: https://www.nature.com/articles/s41396-019-0545-2
	F4 Outcome: At least 5 major QTLs/genes that are stable across environment and management, for all rice mega-environments, integrated in the respective varietal development pipelines	• Adoption of CGIAR materials with enhanced genetic gains	In early 2020, preliminary analyses of the antenna and reference panels were accomplished for phenotypic data available in 2019. Both within and across site AMMI analyses for GxE were performed showing site groupings of traits. Since more complete panel data is now available, we will work closely with CoA 4.1 and 4.2 to analyze these datasets. Also, delivery of major QTLs/genes is closely linked to FP5, CoA 1 on the use of genetic diversity. Four varieties in the AP now have high quality genome builds, allowing extension of the antenna panel SNP set for analyses of its phenotypic data.	2020 extended to 2021 - Contribution of G, E and M to QTL/gene effect determined using multi-environment GWAS analysis	Extended	SNP and phenotypic data from the antenna (AP) and reference panels (RP) are available from our project shared site, and AMMI analyses on AP data have been loaded in a shared gdrive folder (link below). A publication on new reference genomes that includes AP varieties is available from Scientific Data. Personnel limitations meant slower than expected progress. With completed phenotyping of the AP and RP and cross-cluster teamwork with input from a consultant, data analyses will be completed this year.	AP panel SNP data at FP4 website: https://sites.google.com/a/irri.org/demo-fp4-gra/info-on-panels" style="(https://sites.google.com/a/irri.org/demo-fp4-gra/info-on-panels) AMMI and other preliminary analyses (access granted on request): https://drive.google.com/drive/folders/1xDBkdR403k98ahB9lZkuX_igEJvyECCQ?usp=sharing Zhou et al publication on new reference genomes including AP varieties: https://www.nature.com/articles/s41597-020-0438-2" style="(https://www.nature.com/articles/s41597-020-0438-2)

	F4 Outcome: A functional open access rice data hub that allows Global users to fast track their research by exploiting available phenotypic and genotypic information and data analysis tools	• Increased conservation and use of genetic resources	We implemented analysis software for crop genomics in Galaxy via a CropGalaxy server available worldwide. This merged and built on two previous efforts serving slightly different communities, RiceGalaxy and EiB-Galaxy. New tools were added for GWAS and post-GWAS. A training workshop on CropGalaxy was held during the Bioinformatics Community Conference 2020 (BCC2020), an Open Bioinformatics Foundation virtual conference. We plan to continue adding new tools to CropGalaxy and hold annual training workshops. While phenotype data is available through the FP4 website, it is not yet in Galaxy. Progress was hampered due to personnel constraints.	2020 extended to 2021 - Rice Data Hub with GRISP phenotyping and initial Reference Panel datasets and pilot analysis tools in place	Extended	Crop Galaxy can be accessed globally by the public via http://cropgalaxy.excellenceinbreeding.org . Tools implemented in CropGalaxy can be browsed using the left navigation bar. For example, one of the GWAS tools can be seen here: http://cropgalaxy.excellenceinbreeding.org/?tool_id=gemma-assoc-lmm&version=v.01&__identifer=psrm4m957g. Datasets can be browsed in the Shared Data - Data Libraries section: http://cropgalaxy.excellenceinbreeding.org/library/list. Two training courses were held during 2020. The Crop Galaxy workshop at BCC2020 had 25 participants representing while an IRRI Education online course "SNPs to GWAS" had 43 participants from Bangladesh, China, Indonesia, India, Philippines, Thailand and Tunisia. Currently, we have begun implementing an instance of BreedBase at IRRI to host manual and HTP data on the AP and RP (BreedBase is an open source platform developed by the Mueller group at Cornell). We will extend this to include additional tools for machine learning, GWAS and genomic selection/prediction. This system will supplant flat file data storage and the tools and data libraries provided by CropGalaxy. We envision this will become the CRP Rice Data Hub, hosted by the Department of Science and Technology (DOST-ASTI) in the	CropGalaxy analysis platform: http://cropgalaxy.excellenceinbreeding.org/" style="(http://cropgalaxy.excellenceinbreeding.org/) SNP-Seek database: https://snp-seek.irri.org/ Crop Galaxy training workshop at the BCC2020: https://bcc2020.sched.com/event/c9H2/galaxies-for-crop-science" style="(https://bcc2020.sched.com/event/c9H2/galaxies-for-crop-science)

						Philippines.	
F5	F5 Outcome: Rice diversity in rice gene banks used globally for identification of traits and discovery of new genes	• Increased conservation and use of genetic resources	Some highlights for 2020 have been 1) validation of aus donors for grain Zn content using biparental populations and mainstreaming of these to the breeding program; 2) identification of donors, GWAS peaks and QTLS for stagnant flooding and anaerobic germination from diverse aus germplasm, and publication of results from related work; 3) identification of lines for direct seeding breeding programs using best-of-the-best studies where diverse germplasm was chosen based on prior characterization for drought, and identification of GWAS peaks for drought recovery at seedling stage where underlying candidate genes show similarity to ones reported for drought recovery in maize.	2020 extended to 2021 - 40% of targeted traits/donors/QTLs/ genes identification achieved, diversity annually, 80% of the new diversity analysis accessions sequenced	Extended	Pandemic lockdown resulted in the loss of dry season trials that will be done during 2021. Publications on grain zinc studies form GWAS on diverse aus rice populations and validation in biparental publications are nearing completion and will be submitted in 2021. A number of papers on drought and anaerobic germination were published in 2020. Analyses and manuscripts on drought and root related studies are nearing completion, and new donors for direct seeding have been identified.	Tarun JA, Mauleon R, Arbelaez JA, Catausan S, Dixit S, et al (2020) Comparative transcriptomics and co-expression networks reveal tissue- and genotype-specific responses of qDTYs to reproductive-stage drought stress in rice (Oryza sativa L.). Genes 10:1124.doi:10.3390/genes11101124 (open access) Ghosal S, Quilloy FA, Casal C, Septiningsih EM, Mendioro, MS & Dixit S (2020) Trait-based mapping to identify the genetic factors underlying anaerobic germination of rice: Phenotyping, GXE, and QTL mapping.BMC Genetics21:1-13.doi:10.1186/s12863-020-0808-y (open access) Mondal S, Khan MIR, Entila F, Dixit S, Sta. Cruz PC, et al (2020) Responses of AG1 and AG2 QTL introgression lines and seed pre-

							treatment on growth and physiological processes during anaerobic germination of rice under flooding. Scientific Reports 10:10214.doi:10.1038/s41598-020-67240-x (open access) Mondal S, Khan MIR, Entila F, Dixit S, Sta. Cruz PC, et al (2020) Growth, productivity and grain quality of AG1 and AG2 QTLs introgression lines under flooding in direct-seeded rice system. Field Crops Research 248:107713.doi:10.1016/j.fcr.2019.107713 (pay-walled)
	F5 Outcome: Novel tools for precision biotech breeding based on genetic diversity shared open access and globally, including protocols for gene editing and genetic transformation		Seventeen new genes for major diseases and pests in the IRRI 154 background were released and made available to the breeders. These have never been available in elite backgrounds before, and marks a step-change in breeding for these traits. Over 200 trait markers implemented on the RiCA v4 panel at Agriplex. These are now being rolled out to other service providers. Setbacks: loss of materials during the covid-19 lockdown	2020 - 50% of the targeted breeding tools and resources developed and used in breeding programs. Use of gene editing for the validation of genes involved in adsorption of cadmium	Complete	Summaries of deployed genes are available online. The trait markers on the RiCA v4 panel are still being analyzed for performance but will be made available on IRRIs genotyping service laboratory (GSL) website.	https://docs.google.com/spreadsheets/d/14zoNdSJ61TwoeeIoXx6y-vF_V2UdbyajOQUBEWSNXF0/edit#gid=0

			has severely impacted ongoing deployment efforts.				
	F5 Outcome: New rice varieties resulting in 1.3 % genetic gain in intensive systems	• Adoption of CGIAR materials with enhanced genetic gains	Several varieties have been nominated for adaptive trials in the Philippines. Two varieties have been released in favorable lowlands in Bangladesh and three varieties have been released in Mozambique with significant yield advantage over checks. The varietal development process has been accelerated by adoption of OneRice breeding strategy of IRRI involving population improvement using elite lines, hence the nominated/released varieties are expected to perform better year-on-year.	2020 - 10 varieties released for release with 5% higher yield and meeting national quality requirements	Extended	Two lines are released in Bangladesh, three in Mozambique, and 12 promising irrigated lowland lines nominated to multi-location adaptive trials/national trials in the Philippines. In India, 34 advanced lines and 49 donors were used as one of the parental lines in national breeding programs for the favorable ecologies.	No evidence.
	F5 Outcome: Rice varieties with 20, 15, 10% reduction in yield loss caused by factors induced by climate change, in mega deltas, rainfed lowlands, and uplands, respectively	• Enhanced capacity to deal with climatic risks and extremes (Mitigation and adaptation achieved)	Six varieties were released in the rainfed ecosystems in the Philippines. Similarly, two more varieties have been nominated in Nepal for flood prone ecosystems in Nepal. Other countries such as India, Bangladesh, Tanzania, Mozambique, etc. currently engage in screening breeding lines shared from IRRI headquarters and will advance them into the release pipelines this year. More lines are being tested in the network in 2021 to catch up with the time lost in 2020. The Direct Seeded Rice (DSR) breeding network is a	2020 extended to 2021 - 5-10 elite breeding lines and/or varieties combining tolerance of two to three of the relevant stresses in the three ecosystems developed, having 25-50% reduction in yield losses	Extended	There has been a delay in some activities due to termination of trials at HQ and in the regions because of the covid-19 lockdown in 2020. All possible efforts are being made to catch up to the lost time in the current dry season and in the upcoming wet-season.	https://www.pinoyrice.com/rice-varieties/

			particular addition to the effort.				
	F5 Outcome: High quality and high nutritious rice varieties that are preferred by men and women farmers and consumers	• Increased access to diverse nutrient-rich foods	We have conducted a genome-wide association study using a combined population panel of indica and japonica rice varieties, and identified the underlying genetic networks that reduce (Progastricsin) PGC to 2 %. Several breeding lines possessing low chalk genetic regions (0-5%) were identified to support future breeding programs to improve the grain quality of elite genetic material with high yielding potentials. Three lines to possess head rice yield of 55 % were identified, while many of the lines shown to possess median of head rice yield 45 %.	2020 - Breeding lines possessing low chalk (0-5%), higher head rice recovery (60 55% HRR), better cooking quality	Complete	Several breeding lines possessing low chalk genetic regions (0-5%) identified. After thorough screening of breeding material, 3 lines were that possess head rice yield of 55 % were identified, while many of the lines were shown to possess median of head rice yield 45 %.	https://onlinelibrary.wiley.com/doi/10.1111/pbi.13516 https://academic.oup.com/jxb/article/70/19/5115/5506701
	F5 Outcome: Standardized design, data collection, analysis and management implemented across the program	• Increased conservation and use of genetic resources	IRRI's global market segmentation work is completed. The breeding programs are currently being aligned to the markets segments which will work with the selected NARES partners in respective market segments based on maturity and other considerations. OneRice breeding strategy and framework has been completed and launched at IRRI in early 2020. This standard framework provides the breeding programs an end to end and a rapid varietal developments and	2020 - Demonstrated acceleration in breeding cycle duration; Field-based RGA protocol established aswell as scaling of DH development	Complete	This milestone has been updated during the 2019 FP5 meeting as follows: "Develop market segment; establish maturity groups (identify standard checks for different environments); develop product profiles; breeding pipelines defined and characterized; separation of pre-breeding from core breeding operations; improve rate of genetic gain through optimization of one component of the breeders' equation; data management; breeders' reference panel established".	https://drive.google.com/drive/folders/1Z3rsBPLpkSeMYT1s_mQZojuketzMuL7K

			dissemination, based on proven best practices in breeding. Irrigated core panel has been established and rainfed and Direct Seeded Rice (DSR) core panels are also in advance stages of development.				

Table 6: Numbers of peer-reviewed publications from current reporting period (Sphere of control)

	Number	Percent
Peer-Reviewed publications	277	100.0%
Open Access	201	72.56%
ISI	277	100.0%

Table 7: Participants in CapDev Activities

Number of trainees	Female	Male
In short-term programs facilitated by CRP/PTF	19359	38235
In long-term programs facilitated by CRP/PTF	120	147
PhDs	48	61

Table 8: Key external partnerships

Lead FP	Brief description of partnership aims (30 words)	List of key partners in partnership. Do not use acronyms.	Main area of partnership (may choose multiple)
F1	Collaboration with Washington State University to implement RCT for impact assessment of RICE technologies	• WSU - Washington State University	• Research
F1	Collaboration with Newcastle University productivity and yield gap analysis	• Newcastle University	• Research
F2	Supervision of a PhD student from the Department of Global Agricultural Sciences, The University of Tokyo, Japan	• UT - University of Tokyo	• Research • Capacity Development • Policy
F2	Collaboration with University of Arkansas, Fayetteville, USA on consumer preference modeling	• University of Arkansas	• Research
F2	Collaboration on food systems research	• AVRDC - The World Vegetable Center	• Research
	Collaboration with food systems group on food systems	• WUR - Wageningen University and Research	

F2	research	Centre	• Research
F2	Collaboration with School of Business and Professional Studies, Upper Iowa University, Fayette, IA, USA on market research	• Upper Iowa University	• Research • Capacity Development
F3	In a framework of Excellence in Agronomy 2030 Initiative, AfricaRice, IITA, CIMMYT and iSDA develop and disseminate field-specific nutrient management decision support tool for maize and rice.	• iSDA - Innovative Solutions for Decision Agriculture	• Delivery • Research
F3	In a framework of Excellence in Agronomy 2030 Initiative, AfricaRice, IITA and SAA develop and disseminate site-specific nutrient management decision support tool for cassava, maize and rice in Nigeria.	• SAA - Sasakawa Africa Association	• Delivery • Research
F3	AfricaRice, IRRI, and SARMAP jointly conduct impact assessment of COVID-19 on crop production and food security in Senegal and Tanzania using remote sensing technologies.	• SARMAP - Sarmap SA	• Research

Table 9: Internal Cross-CGIAR Collaborations

Brief description of the collaboration	Name(s) of collaborating CRP(s), Platform(s) or Center(s)	Optional: Value added, in a few words
IRRI actively contributed to the activities and publications of the CGIAR Foresight Team, including the development of the CGIAR Foresight Report, and the Future of X that provides perspectives on food, land and water systems in developing countries. On the basis of these studies, new collaborations have been established with other centers (World Fish, CIP, etc) to examine the future trend of rice-based systems and, in turn, guide the agri-food transformation.	PIM, Fish	Publication of the CGIAR Foresight Report underway. More publication in the pipeline
Collaboration on the development of market intelligence and product profiles	EiB	Efficiency benefits
Active participation in PIM COVID-19 value chain fractures working group. Collecting and reviewing evidence of COVID-19 inflicted fractures in food value chains in the developing world.	PIM	Scientific
Excellence in Agronomy 2030 Initiative was launched in 2020. 2-yr incubation project has been funded by BMGF.	AfricaRice, CIAT, CIMMYT, CIP, ICARDA, ICRAF, ICRISAT, IFPRI, IITA, IRRI	Scientific and efficiency benefits

EiB supports Crop Galaxy for use in analyses by CG and partners.	EiB	Easy access to bioinformatics tools

Table 10: Monitoring, Evaluation, Learning and Impact Assessment (MELIA)

Studies/learning exercises planned for this year (from POWB)	Status	Type of study or activity	Description of activity / study	Links to MELIA publications
S3891 - Rural transformation and the future of rice-based food systems	Completed	Ex-ante, baseline and/or foresight study	The activity consists of analyzing the impacts of rural transformation on the future of cereal-based agri-food systems. The study stressed that the staples maize, wheat, and rice, will continue to play an important role in supplying most of the daily calories intake around the globe. By 2050, the per capita availability of land will decline from 28 to 47% in Africa, and from 30 to 42% in SSA. The highest demand increase is observed for rice (47%) compared to other cereals. Rice productivity could increase between 40 and 42% under increased investment n international and national agricultural research in SSA.	https://www.sciencedirect.com/science/article/pii/S221191242030095X
S3897 - New plant types possessing as many as 10 QTLs identified after profiling with 30 trait-based SNPs	On Going	Synthesis (secondary) study	A total of 1136 double haploids (DP) were profiled using 30 trait-based SNPs to elucidate inherent genetic attributes. Thirteen DH possessed 10 QTLs each while 56, 116, 182, 185 and 184 DH each possessed 9, 8, 7 6 and 5 QTLs respectively. These are good candidates to feed the parent development pipeline.	

Table 11: Update on Actions Taken in Response to Relevant Evaluations

Name of the evaluation	Recommendation number (from evaluation)	Text of recommendation (can be shortened)	Status of response to this recommendation	Concrete actions taken for this recommendation.	By whom (per action)	When (per action)	Link to evidence
No RICE-relevant evaluations were concluded in 2020. The CAS-commissioned external evaluation of RICE was only finished with a report early 2021.	NA	NA	Complete	NA	NA	NA	NA

Table 12: Examples of W1/2 Use in this reporting period (2020)

Please give specific examples, one per row (including through set aside strategic research funds or partner funds)	Select broad area of use of W1/2 from the categories below - (drop down) Selecet only one category.
Impact of covid-19 on rice-based diets and consumers' attitudes towards nutrition interventions	Research
Policy options for mitigating impacts of covid-19 on domestic rice value chains and food security in West Africa.	Research
Assessment of the state of rice value chain upgrading in 15 West African countries	Policy
Book on sustainable rice straw management, which can assist policy makers in reducing greenhouse gas emissions and air pollution in South and Southeast Asia	Policy
Establishment of the Goronyo Rice Innovation Platform for rice value chain upgrading in Nigeria.	Partnerships
Database to help value chain actors introduce novel products in Indian diets	Partnerships
Evaluating the impact of Stress-Tolerant Rice Varieties through remote sensing and econometric	

Methods. Remote sensing techniques were used to examine flooding and the density of green vegetation in the flood-prone areas of Bangladesh	Other Monitoring, learning, evaluation and impact assessment (MELIA)
Contribution to the dialogue on Rice Tarification Law in the Philippines	Policy
The Internet-of Things based irrigation advisory service (AutoMonPH) that entails efficient water management, continuous monitoring, reporting and verification of water management practices, was developed and piloted with a multi-stakeholder interface in the Philippines.	Research
The Sustainable Rice Platform (SRP) was promoted in Vietnam through a field demonstration (13 ha) combining Small Farmers, Large Field model; 1M5R; and SRP.	Delivery
RiceAdvice and basic good agricultural practices were disseminated to a total of 14,900 farmers in Nigeria and Senegal	Delivery
45 demonstration plots were established to disseminate Good Agricultural Practices, and 1,080 rice farmers were trained though farmer field days in Rwanda	Capacity development
In Madagascar, multi-year experiments on bio-diversified upland rice based cropping systems were evaluated. Participatory designing identified promising diversification options that include maize, cassava, pulses, and legume cover crops as rotational crops.	Research
In Madagascar, field experiment revealed that Stylosanthes guianensis (stylo) absorbed 10-26 times more P than rice, maize, or soybean under typical P-deficient uplands in the region. Subsequent field	Research

experiments showed that the yield of upland rice was higher after cultivation of stylo than cultivation of maize or rice.	
A survey was conducted in the Philippines to review the government policies supporting agricultural mechanization and assess the management and utilization of mechanical transplanters including the perception of various stakeholders.	Policy
Establishment of the ASEAN RiceNet breeding network	Partnerships
To support rice breeding programs, global market segmentation was accomplished, with data on ecology, agronomy, trait, and grain quality requirements of rice across the world. Product concepts and profiles were developed for priority segments	Research
High-Zn breeding lines from CIAT/Cirad were tested and five lines combining local adaptation with high grain Zn were selected for a possible fast-track variety release.	Research
Three very promising low Glycemic Index rice (GI=20-22) products were identified which can be used as parents for breeding low GI rice.	Research
Four high-yielding varieties were evaluated through the AfricaRice-hosted Breeding Task Force and were released in Niger for irrigated lowlands, including one salt tolerant and aromatic variety.	Delivery
AfricaRice and FOFIFA started developing red rice varieties with high yield potential.	Research

A unified pipeline for pre-breeding activities to connect diversity in the genebank to elite breeding programs. This follows a stage-gate system to ensure rigorous development of traits, ensuring the information and products needed to use these effectively in a breeding program are developed at an appropriate standard of quality.	Research
Training on CropGalaxy tools during Bioinformatics Community Conference 2020.	Capacity development
Phenoi software to analyse drone and satellite images.	Research
A novel NIR-image segmentation method for the precise estimation of above-ground biomass in rice crops.	Research
An unmanned aerial vehicle (UAV) technology for estimating leaf N content in rice crops from multispectral imagery.	Research
Evaluation of MAGIC rice lines under low radiation conditions for two different environments.	Research
Rice Blast pathogens characterization in Colombia.	Research
Sampling methods for assessing intra- and inter-genetic diversity in O. glaberrima, O. sativa, and O. barthii compared.	Research

A high-yielding rice variety SEBERI 2 was released in Niger in 2020 for irrigated lowland production systems.	Delivery
Cold-tolerant and nutritious red rice lines identified for Madagascar highlands.	Research

Table 13: CRP Financial Report

	Planned Budget 2020*			Actual expenditure*			Difference*			Comments
	W1/W2	W3/Bilateral	Total	W1/W2	W3/Bilateral	Total	W1/W2	W3/Bilateral	Total	
F1 - Accelerating impact and equity	US$ 3,060,241.02	US$ 9,275,349.82	US$ 12,335,590.84	US$ 2,028,845.00	US$ 7,356,125.00	US$ 9,384,970.00	US$ 1,031,396.02	US$ 1,919,224.82	US$ 2,950,620.84	-
F2 - Upgrading rice value chains	US$ 1,397,348.77	US$ 1,586,832.90	US$ 2,984,181.67	US$ 821,924.00	US$ 943,514.00	US$ 1,765,438.00	US$ 575,424.77	US$ 643,318.90	US$ 1,218,743.67	-
F3 - Sustainable farming systems	US$ 2,270,918.78	US$ 11,226,703.92	US$ 13,497,622.70	US$ 1,891,469.00	US$ 10,028,044.00	US$ 11,919,513.00	US$ 379,449.78	US$ 1,198,659.92	US$ 1,578,109.70	-

F4 - Global Rice Array	US$ 2,782,169.02	US$ 2,686,974.72	US$ 5,469,143.74	US$ 2,190,370.00	US$ 2,152,015.00	US$ 4,342,385.00	US$ 591,799.02	US$ 534,959.72	US$ 1,126,758.74	-
F5 - New rice varieties	US$ 3,133,700.61	US$ 21,037,028.57	US$ 24,170,729.18	US$ 2,163,099.00	US$ 22,029,358.00	US$ 24,192,457.00	US$ 970,601.61	US$ - 992,329.43	US$ - 21,727.82	-
Strategic Competitive Research grant	US$ .00	US$ .00	US$ .00	US$ .00	US$ .00	US$ .00	US$ .00	US$ .00	US$ .00	No competitive grants in 2020
CRP Management & Support Cost	US$ 1,271,622.00	US$ .00	US$ 1,271,622.00	US$ 1,026,622.00	US$ .00	US$ 1,026,622.00	US$ 245,000.00	US$ .00	US$ 245,000.00	-
CRP Total	**US$ 13,916,000.20**	**US$ 45,812,889.93**	**US$ 59,728,890.13**	**US$ 10,122,329.00**	**US$ 42,509,056.00**	**US$ 52,631,385.00**	**US$ 3,793,671.20**	**US$ 3,303,833.93**	**US$ 7,097,505.13**	

Annexes

Table Annexes

FP	Detailed Annex
F1: Accelerating impact and equity	With the support of SPIA and the RICE CRP, IRRI and University of Arizona conducted the first phase of the project "Evaluating the Impact of Stress-Tolerant Rice Varieties Through Remote Sensing and Econometric Methods". Remote sensing techniques were used to examine flooding and the density of green vegetation in the flood-prone areas of Bangladesh.A noticeable policy engagement is the recent IRRI contribution to the dialogue on Rice Tarification Law (RTL) in the Philippines. Based on two studies on RTL published in 2020, the Foresight team proposed policy measures that the Philippine government can use to help rice farmers to adapt and develop profitable business in agriculture or outside, particularly those who are negatively impacted by the reform. In particular, the IRRI's study emphasized that investments and policy support measures are needed in rural areas of the Philippines to create more opportunities for on-farm diversification towards higher value crops than rice.A new study at IRRI examined the effect of IRG ancestry on the rice productivity of farmers in Eastern India in an econometric framework. The study also examines the country of origin of all IRG accessions in the ancestry of improved rice varieties grown and characterizes the most widely used progenitors. Results indicate that a 10% increase in the genetic contribution of IRG accessions to an improved rice variety is associated with a yield increase of 27%. Rapid population growth in Africa and Asia is projected to lead to an unprecedented number of youth entering the labour market in the next few decades. Youths' role in agriculture or the agri-food sector has received increased interest as a way to provide employment opportunities for young job seekers given the "demographic dividend" most developing countries are showcasing. Engaging youth is a broad concept which depends on broader socio-economic factors ranging from age, gender, educational level, access to credit, ownership of land, kinship, marriage, and type of affiliations with social or institutional networks, to list a few. In 2020, IRRI developed a strategy plan for Youth in rice agri-food systems in Asia and Africa. The strategy lays out two important components 1) The framework of engagement encompassing the objectives, research areas, and theory of change and 2) A plan for operationalizing the strategy. The IRRI's 5-year youth strategy aims to increase our knowledge and generate evidence about the situation and needs of youth engaged in the rice AFS so that the sector can become an attractive and remunerative livelihood opportunity, including employment and entrepreneurship. Through implementing this Youth Strategy, IRRI seeks to become a knowledge and innovation pioneer and take a leadership role in bringing young people to the forefront of rice AFS. The first two years (2020-22) will involve research to establish the foundational understanding of youth in rice AFS and designing action research plans and interventions for the following years. The medium term (2022-2025) will be focused on facilitating the creation of opportunities for youth in rice AFS in Asia and Africa. This will involve setting strong partnerships for research for development and testing interventions with the aim to learn from them.A recent study at AfricaRice investigates the linkages between gender, development and utilization of technological innovations in Ghana and made the following recommendations:(1) Gender issues are not identified and addressed during the technology development process. Lack of consultation with the target group throughout the agricultural innovation development process is likely to create room for the development of undesirable characteristics of improved rice technologies.(2) Although participatory varietal selection (PVS) is conducted, bringing various target groups, women are generally unable to freely express themselves when in the company of male counterparts. Women are also constrained

	by time due to their relative pre-occupation with domestic activities. Women are hence disadvantaged in terms of contributing to the innovation development process.(3) Research institutions' mandate does not emphasize gender mainstreaming, but food security and livelihood improvement. In the absence of institutional transformation and incentives, gender issues are not addressed in ARD.(4) Low implementation of gender mainstreaming policies and/or strategies by the research institutions is due to the lack of gender training and capacity building for scientists and research managers.(5) Since gender mainstreaming is more theoretical than practical, policymakers should include gender mainstreaming as part of the core mandate of research institutions. This will enable research institutions to consider gender issues from the onset and make gender forms an integral part of research and development process.(6) Given that women rice farmers' needs and concerns differ from that of their male counterparts, the government should invest in the development and promotion of gender-sensitive improved rice technologies for inclusiveness, equity and sustainability of rice sector.
F2: Upgrading rice value chains	
F3: Sustainable farming systems	IRRI: The Sustainable Rice Platform (SRP) was promoted in Vietnam through a field demonstration (13 ha) combining the 'Small Farmers - Large Field' model, the management practices '1 Must Do - 5 Reductions' (1M5R), and SRP guidelines. This generated several scientific based evidences of the management practices '1M5R and mechanized transplanting such as: mean grain yield and net income increased by 5-10%; reduced seed rate by 40-60%, reduced pesticide application by 30-40%, and reduced greenhouse gases by 30%. A survey was conducted in the Philippines to review the government policies supporting agricultural mechanization and assess the management and utilization of mechanical transplanters including the perception of various stakeholders. Reasons for poor adoption of Alternate Wetting and Drying (AWD) in Bangladesh was identified. Results of field study conducted for three years (2016–2019) in Polder 30 in Bangladesh identified promising cropping systems with improved varieties.AfricaRice: In Rwanda, country-specific good agricultural practices (GAP were developed. 45 demonstration plots were established to disseminate the GAPs and 1080 rice farmers were trained though farmer field days in Rwanda. Promising site-specific nutrient management practices were identified in Rwanda, Senegal, and Tanzania. Impact of AWD on yield, water productivity, and weeds were quantified in Côte d'Ivoire. Crop diversification options were jointly tested with farmers in Cote d'Ivoire, Madagascar, Senegal, and promising options were identified together with farmers. Promising pieces of small-scale sowing equipment (seeders and fertiseeder) were developed which can reduce the labour input for sowing by 70-80% compared to manual sowing in Madagascar.CIAT: A pilot project with a private company in Panama was launched in 2020 to increase productivity and reducing production costs. Results from the first demonstration plots showed average production cost was reduced by 22.3% and profitability was doubled as compared to conventional management. The FLAR's (Latin America foundation for irrigated rice) Rice/Soybean Rotation Project began in 2015 with the objective of validating the adaptation of soybean cultivars and establishing agronomic management practices for rotation systems with rice in the tropical zone of Latin America and the Caribbean. As a result of this project, Nicaragua, through its Rice Farmers Association, is facilitating the registration and seed commercialization, by a private company, of at least one soybean variety introduced by FLAR from Brazil. Same result was obtained in Colombia, where the National Rice Farmers association facilitated the registration and multiplication of two soybean varieties introduced by FLAR. In Venezuela, soybean became the most valuable alternative for rotation with rice, as a consequence on this project. At this point, research and commercial agreements for soybean variety release and seed production are on going with funding and capacities allocated by FLAR partners themselves.CIRAD: In Madagascar, multi-year experiments on bio-diversified upland rice based cropping systems were evaluated. Participatory designing identified promising diversification options including maize, cassava, pulses and legume cover crops as rotational crops. In Cambodia, farm typology in the major rice production area was carried-out. In Ivory Coast, upland rice based direct seeding systems under conservation agriculture had more climate resilience than conventional systems with tillage. In Burkina-Faso, on farm trials on lowland rice system showed (i) a high carry-over effect of potatoes rotation with rice for soil fertility; and (ii) a good profitability (return on investment) of low dose urea land-filling at sowing for rice subject to floods.JIRCAS:

	In Madagascar, field experiment revealed that Stylosanthes guianensis (stylo) absorbed 10-26 times higher P uptake than rice, maize, or soybean under typical P-deficient uplands in the region. Subsequent field experiment in the next season showed that the yield of upland rice in where stylo was previously cultivated was greater than those grown after maize or rice. Considering the high biomass and high P absorption capacity, and the effect on subsequent rice yield, stylo can be a promising option as cover/relay crop to enhance P cycling in upland rice-based cropping system under P-deficient condition in the region.
F4: Global Rice Array	For Coa 4.2: The main limitation was to mantain local personel in NARES experimental stations. For instance, data on the RP for 4 sites was stored in a database. Software was developed to optimize image analysis, and new tools to estimate climate response variables such as panicle fertility were developed.For Coa 4.5: Genotype data is in crop galaxy and phenotype data is available through the Project website, it is not yet in Galaxy. Progress was hampered due personnel constraints.
F5: New rice varieties	Several initiatives are being done commonly be multiple Centers:Global maturity system: Efforts were initiated to define and establish a global relative maturity system in collaboration with RICE CGIAR Centers and private sector partners.Lowering the glycemic index: One protocol for rice processing was identified and used by AfricaRice to evaluate different rice varieties. Three very promising Low GI rice (GI=20-22) products were identified and can be used as parents for breeding low GI rice. IRRI investigated the glycemic index (GI) of breeding and develop materials in vitro and found that many of them are in the high GI levels. Screening of 320 Genebank materials identified 3 donor lines validated through in vivo human feeding trials as low GI.Product management initiative: Product managers were hired for Asia and East and Southern Africa to develop product profiles of key rice popular varieties and developed recommendations for product positioning of new products.HTP for HRR and grain Zn estimation: IRRI acquired several Zaccaria PAZ-1/DTA test mills to enable HRR phenotyping – 5 units are for use in HQ and 3 units are for India and Bangladesh. Several XRF machines were also acquired for Zn phenotyping.Zinc biofortification: In LAC, CIRAD and CIAT developed new breeding material and conducted regional multiplication trials to release varieties with increased grain Zn concentration. JIRCAS also collaborated with CIRAD on Zn biofortification in Madagascar (with HarvestPlus and FOFIFA). New high-Zn donors having more than twice the grain Zn concentration compared to local variety X265 were identified using Genomic Selection. High-Zn breeding lines from CIAT/CIRAD were tested and 5 lines combining local adaptation with high grain Zn were selected for a possible fast-track variety release. Evaluations under the direction of the seed board of Madagascar are ongoing.Publications: Six peer-reviewed articles were published in scientific journals, two more papers are currently under review. One paper came out in early 2021 reporting findings of a study conducted on genetic gain over the period 2005 to 2014.

RICE's Mission

RICE's aims to reduce poverty and hunger, improve human health and nutrition, adapt rice-based farming systems to climate change, promote women's empowerment and youth mobilization, and reduce rice's environmental footprint.

Through research and development in collaboration with large numbers of partners in public and private, national and international research and development institutions, national agricultural research and extension systems, and nongovernmental organizations, RICE expects to

- help at least 13 million rice consumers and producers, half of them female, to exit poverty by 2022, and another 5 million by 2030;
- assist at least 17 million people, half of them female, out of hunger by 2022, rising to 24 million by 2030; and
- assist at least 8 million people, half of them female, to meet their daily Zn requirements from rice by 2022, rising to 18 million by 2030.

These outcomes will be possible by

- helping at least 17 million more households to adopt improved rice varieties and/or farming practices by 2022 and a further 19 million by 2030;
- improving the annual genetic gain in rice (as measured in breeders' trials) to at least 1.3% by 2022, rising to 1.7% by 2030;
- helping increase annual global (milled) rice production of 479 million tons in 2014 to at least 536 million tons by 2022 and to 544 million tons by 2030;
- increasing water- and nutrient-use efficiency in rice-based farming systems by at least 5% by 2022, rising to 11% by 2030, and
- helping reduce agriculture-related greenhouse gas emissions in rice-based farming systems by at least 28.4 megatons carbon dioxide (CO_2) equivalent/year by 2022 and by a further 28.4 megatons CO_2 equivalent/year by 2030, compared to business-as-usual scenarios.

Flagship projects

1. Accelerating impact and equity
2. Upgrading rice value chains
3. Sustainable farming systems
4. Global Rice Array
5. New rice varieties

CGIAR RESEARCH PROGRAM ON Rice

CGIAR is a global research partnership for a food-secure future. Its science is carried out by the 15 research centers of the CGIAR consortium in collaboration with hundreds of partner organizations.

AfricaRice

IRRI

CIAT
International Center for Tropical Agriculture
Since 1967 Science to cultivate change

cirad
AGRICULTURAL RESEARCH FOR DEVELOPMENT

IRD
Institut de Recherche pour le Développement
FRANCE

JIRCAS