



**RESEARCH
PROGRAM ON
Rice**

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

2021 Annual Report – 28 February 2022



2021 RICE 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.

The responsibility for this publication rests solely with the CGIAR Research Program on Rice Agrifood Systems. cc CGIAR Research Program on Rice Agrifood Systems 2017

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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

Two major challenges impacted on the activities of RICE in 2021: the restrictions caused by the Covid-19 pandemic, and the transition process of the OneCGIAR. The continued lockdowns negatively affected the productivity of staff, particularly families with small children. Also continued travel restrictions hampered execution of field work and surveys. The reform process towards OneCGIAR created many anxieties and uncertainties, and took a lot of energy and time from scientists. Especially the participation in various working groups, and the development of the new Initiatives, considerably diverted scientist and support staff away from RICE. With creative responses to these challenges, RICE was able to achieve impressive outputs: 369 refereed journal publications (74% open access), 122 new and updated Innovations, 13 OICRs, and 3 Policies. Out of the 38 Milestones, 30 were fully completed, 7 partially completed, and 1 changed. RICE centers and partners provided short-term capacity development to 43,360 participants, of which 33% were female. Throughout the year, a total of 232 scholars (38% female) were enrolled in long-term capacity development.

The year 2021 being the last one of the CRP, however, we placed emphasis on the further documentation of adoption of technologies and large-scale impacts. The following impacts are highlighted:

The improved rice management package '1 Must Do-5 Reductions' was reached by 104,448 smallholder rice farmers and adopted on 114 thousand ha in the Mekong River Delta of Vietnam, resulting in 19- 36% higher income.

- A meta-analysis compared Site Specific Nutrient Management (SSNM) with farmers' fertilizer practice

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for maize, rice and wheat using 61 published papers across 11 countries. Relative to the farmer practice, across the crops maize, rice and wheat, SSNM increased grain yield by 12% and profitability by 15% with 10% less fertilizer nitrogen applied.

- From the cultivation of the flood-tolerant rice variety SS1, households in Assam, Odisha and West Bengal in India gained an additional yield of 527-1,023 kg/ha, amounting to an additional income 67-134 \$/ha.

- Over 780,000 farm households in South-East and East Asia adopted improved rice management practices

- Extrapolated (from field adoption rates) areas planted under salinity-tolerant rice varieties in the Mekong River Delta of Vietnam were 195,000-239,000 hectares.

- Within six years after its release in 2008 in Bolivia, the improved rice variety MAG-18, has been adopted by 25% of all Bolivian rice producers and is currently planted on 58% of the total rice area.

- In Ecuador, improved rice variety SFL09 was used by 33% of the rice producers, while in 2019, SFL09 occupied 61% of the sown area.

- In Colombia, digital agriculture tools have reached 24% of rice and maize producers (around 4,000 ha), increasing 2020 yields by 26% on average (41% maize, 12% rice).

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)

- The improved rice management package '1 Must Do-5 Reductions' was reached by 104,448 smallholder rice farmers and adopted on 114 thousand ha in the Mekong River Delta of Vietnam, resulting in 19- 36% higher income.
- A meta-analysis compared Site Specific Nutrient Management (SSNM) with farmers' fertilizer practice for maize, rice and wheat using 61 published papers across 11 countries. Relative to the farmer practice, across the crops maize, rice and wheat, SSNM increased grain yield by 12% and profitability by 15% with 10% less fertilizer nitrogen applied.
- From the cultivation of the flood-tolerant rice variety SS1, households in Assam, Odisha and West Bengal in India gained an additional yield of 527-1,023 kg/ha, amounting to an additional income 67-134 \$/ha.
- The adoption of submergence-tolerant rice varieties in northern Bangladesh increased yield, profit, and home rice consumption by 6%, 55%, and 15% respectively. Over 780,000 farm households in South-East and East Asia adopted improved rice management practices.
- Extrapolated (from field adoption rates) areas planted under salinity-tolerant rice varieties in the Mekong River Delta of Vietnam were 195,000-239,000 hectares.

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- In Bangladesh, high-zinc rice varieties have been developed and released to address the problem of zinc deficiency, particularly among children and pregnant women. The adoption of high-zinc rice in Aman season declined from 59% in 2018 to 7.5% in 2020 among treated farmers and from 12.9% to 1.9% among control farmers. Results indicate that nutrition training has a long-term but diminishing impact on high-zinc rice adoption.
- Rice contract farming in Benin increased productivity by 473 kg per hectare with about 29% higher yields, and delivered \$140 higher income per capita.
- The African countries' CARD policy contributed to increase rice production in 2018 by 10.2 million ton. This resulted from the increasing of area and yield by 23% and 19%, respectively.
- Within six years after its release in 2008 in Bolivia, the improved rice variety MAG-18, has been adopted by 25% of all Bolivian rice producers and is currently planted on 58% of the total rice area.
- In Ecuador, the improved rice variety SFL09 was used by 33% of the rice producers, while in 2019, SFL09 occupied 61% of the sown area.
- In Colombia, digital agriculture tools have reached 24% of rice and maize producers (around 4,000 ha), increasing 2020 yields by 26% on average (41% maize, 12% rice).

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

1.2.1 Overall CRP progress (max 1000 words)

The adoption of improved rice varieties that are tolerant to flooding, drought, and iron toxicity, and that are resistant to viruses has made a significant positive impact. These varieties increased rice yield, helped to raise income, and improved the acceptability of such new technologies among smallholder rice producers in Asian countries (the Philippines, Bangladesh, India), LAC (Argentina, Brazil, Chile, Bolivia, Peru, Ecuador, Colombia, French Guyana, Panama, Nicaragua, Dominican Republic), and African countries (Guinea, Benin, Nigeria, Madagascar, Côte d'Ivoire). Specifically, improved natural resource management practices have increased the income and yield of rice-farming families, while decreasing production costs in Africa, India, and China. Finally, farmer-to-farmer education and training and collective marketing have increased rice yield in Tanzania by 3.1 to 5.3 t/ha and income by USD 148/ha for farmers in Benin. Finally, institutional arrangements such as contract farming increased rice area, yield, and income of smallholder rice farmers in Benin by 23%, 29%, and 50%, respectively.

Thanks to its research portfolios coming into maturity, FP2 made good progress despite COVID-19 restrictions, although the geographical focus narrowed to action sites where staff and partners were in place to carry out the activities. Major progress was made in Africa and Asia in novel market segmentation and a better understanding of the value consumers place on both intrinsic (grain quality, texture, aroma) and extrinsic (packaging, labeling) rice quality attributes. In Africa, attention turned towards the milling industry and novel research was conducted with the aim of improving the industry's

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capacity to improve its governance in upgrading the quality-competitiveness of domestic relative to imported rice. Further, thanks to an innovative protocol for the quantification of rice postharvest losses in sub-Saharan Africa, value chain upgrading strategies can be developed that aim at mitigating these losses. Moreover, new evidence was generated on farmers' access to finance and effects on investment, which enables designing an optimal financial package to support rice farmers. EasyHarvest, an application for web and mobile platforms that facilitates access to harvester services, was successfully piloted in the Philippines. Finally, to divert farmers away from straw burning, mechanized rice straw composting was used to convert crop residues into organic fertilizer.

Despite challenges of COVID-19, FP3 completed all its milestones. IRRI reached 783,529 households, and best management practices increased yield and profit by 1 to 90% and by 15 to 90% in Indonesia, China, Myanmar, Sri Lanka, Thailand and Vietnam. Farm diversification options using vegetables, sunflower, and maize were tested and disseminated in Cambodia, India, and Bangladesh. A study in Myanmar showed positive impact of adoption of best practices and machineries on female farmers' livelihoods including nutrition. In West Africa, 109,000 RiceAdvice recommendations were provided with farmers from 2014 to dry season in 2021. Yield increase with RiceAdvice recommendations was on average 15, 16, 10, and 3%, respectively in Burkina Faso, Mali, Nigeria, and Senegal. In Madagascar, the pilot-scale test of the P-dipping technique which is to dip seedling roots into P-enriched slurry at transplanting was implemented in 300 farmers' fields, and confirmed that this technique increases fertilized P use efficiency by 98%. *Stylosanthes guianensis*, legumes, and vegetables were identified as diversification options in rice-based systems in Africa. Good practices enhanced rice yield and profit in Uruguay.

A key objective of FP4 aimed to understand the GxExM relationships to better define ideotypes targeted to environments and Genome Wide Association Studies (GWAS) peaks useful for breeding for those environments. Analyses of Global Rice Array (GRA) antenna panel (AP) data for grain yield for 57 genotypes identified 7 main environmental clusters from 21 out of 25 sites, while reference panel analyses have identified GWAS peaks that show varying degrees of environment specificity. UAV based phenotyping methods for measuring biomass, greenness, height, and phenology measurements have been optimized across centers; data analysis pipelines and database for UAV images have been developed. Surveys for pathogen diversity and distribution (blast, bacterial blight, viruses, others) have enabled development of molecular tools for identification; application of the markers in PathoTracer has enabled effective monitoring and early season disease diagnosis. An updated project website was launched that includes a datastore for GRA results; new tools and improved documentation were added to Crop Galaxy.

Despite all the challenges and constraints posed by the Covid-19 pandemic, progress has been made in all clusters of activities of FP5. Foundation for high quality rice breeding has been established to address challenges related to climate change in the years to come. The establishment of a dedicated direct-Seeded Rice breeding program, market segmentation, and product concepts are critical for rice breeding effort in the future. In line with the expectations on creating market demanded varieties and rapid varietal turn-around, leading to increased genetic gains, the OneRice initiative has adopted an end-to-end framework. The current breeding programs have a shorter breeding cycle, centralized pre-breeding,

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improved breeding and on-farm trialing network, and a close interaction with NARES partners. Deployment of many genes has progressed, and several new genes brought to completion. To better define the cooking and eating quality of rice varieties, new models are established and used as a detailed selection tool for screening of a variety that can be included as selection criteria in the breeding programs to cater the needs of both farmers and consumers. New methods to analyze on-farm trial data, breeding schemes and index of selection have been developed as part of the unification of breeding analytics pipeline.

1.2.2 Progress by flagships

F1 - Flagship progress:

The adoption of improved rice varieties that are tolerant to flooding, drought, and iron toxicity, and that are resistant to viruses has made a significant positive impact. These varieties increased rice yield, helped to raise income, and improved the acceptability of such new technologies among smallholder rice producers in Asian countries (the Philippines, Bangladesh, India), LAC (Argentina, Brazil, Chile, Bolivia, Peru, Ecuador, Colombia, French Guyana, Panama, Nicaragua, Dominican Republic), and African countries (Guinea, Benin, Nigeria, Madagascar, Côte d'Ivoire). Specifically, improved natural resource management practices have increased the income and yield of rice-farming families, while decreasing production costs in Africa, India, and China. Finally, farmer-to-farmer education and training and collective marketing have increased rice yield in Tanzania by 3.1 to 5.3 t/ha and income by USD 148/ha for farmers in Benin. Finally, institutional arrangements such as contract farming increased rice area, yield, and income of smallholder rice farmers in Benin by 23%, 29%, and 50%, respectively.

Relevance to Covid-19:

The COVID-19 pandemic has impacted several activities planned for 2021. Due to the lockdown and other social distancing measures imposed in focus countries, household and farms surveys planned in 2021 could not be implemented.

- In CoA 1.1, we have been constrained by the limited access to country data used in updating the IRRI Global Rice Model (IGRM).
- Studies and activities planned in CoA 1.2 were also constrained by the restrictions imposed with the COVID pandemic. For instance, in Africa several activities were cancelled, such as the gendered impact assessment of parboiling technology in Nigeria and Benin. Alternative studies were undertaken: expanding the women empowerment assessment in Madagascar, and conducting a capacity and needs assessment for enhancing collective actions by women (women groups in rice farming, in small saving and credit, and in processing and marketing food products).
- Studies and activities planned for CoA 1.3 were combined on-going bilateral projects like the Cereal System Initiative for South Asia (CSISA) and AGGri-Alliance in Asia.
- Policy engagement activities in CoA 1.4 were conducted online due to the travel restriction imposed in some countries.

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- Studies and activities planned in CoA 1.5 and 1.6 were also severely affected. For example, the household survey for the SPIA project assessing the impacts of Stress-tolerant rice varieties in India and in Bangladesh, could not be implemented. Telephone-based surveys were experimented in some countries, but the outcomes were not very satisfactory, due to the reluctance of respondents to release their households' information online. Studies were conducted on the impact of the COVID 19 pandemic on the rice value chain in several Asian and African countries.
- The RICE budget was used to complement the ACIAR funded project "Assessing the impacts of COVID-19 pandemic on rice value chain functions: The case of farmers' cooperatives in Cambodia".

F2 - Flagship progress:

Thanks to its research portfolios coming into maturity, FP2 made good progress despite COVID-19 restrictions, although the geographical focus narrowed to action sites where staff and partners were in place to carry out the activities. Major progress was made in Africa and Asia in novel market segmentation and a better understanding of the value consumers place on both intrinsic (grain quality, texture, aroma) and extrinsic (packaging, labeling) rice quality attributes. In Africa, attention turned towards the milling industry and novel research was conducted with the aim of improving the industry's capacity to improve its governance in upgrading the quality-competitiveness of domestic relative to imported rice. Further, thanks to an innovative protocol for the quantification of rice postharvest losses in sub-Saharan Africa, value chain upgrading strategies can be developed that aim at mitigating these losses. Moreover, new evidence was generated on farmers' access to finance and effects on investment, which enables designing an optimal financial package to support rice farmers. EasyHarvest, an application for web and mobile platforms that facilitates access to harvester services, was successful piloted in the Philippines. Finally, to divert farmers away from straw burning, mechanized rice straw composting was developed as to convert crop residues into organic fertilizer.

Relevance to Covid-19:

In response to the COVID-19 pandemic, several studies were initiated by FP2. First, AfricaRice, CIRAD and IRRI followed up on the previous studies in Global Food Security (Soullier et al., 2020; Arouna et al., 2020) 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. Secondly, IRRI conducted consumer surveys in the Philippines and eastern India on the impact of COVID-19 on rice-based diets and consumers' attitudes towards nutrition interventions. Preliminary results from the Philippines suggest that changes in household dynamics have influenced the type and quantity of food

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consumed, ingredients used, and timing of food consumption. Moreover, changes in the food environment—particularly with respect to affordability, availability, and convenience—may have likewise influenced the types of food consumed and the way consumers acquire and prepare food. In addition, consumers’ attitudes towards food and nutrition have changed during the pandemic. Nutrition, food quality and safety became more important during the pandemic as compared to the past. And interestingly, findings reveal that even in times of a health crisis, taste remains an important consideration in consumer’s food choice. Insights gained from the exploratory study suggest that accounting for consumers’ food choice is important in designing nutrition-sensitive interventions that encourage food environments to improve and protect consumers’ nutritional status and well-being.

F3 - Flagship progress:

Flagship Project 3 (FP3) “Sustainable Farming Systems” had 7 milestones in 2021 (see Table 5). Despite challenges of COVID-19, we completed all the milestones. IRRI reached 783,529 households, and best management practices increased yield and profit by 1 to 90% and by 15 to 90% in Indonesia, China, Myanmar, Sri Lanka, Thailand and Vietnam. Farm diversification options using vegetables, sunflower, and maize were tested and disseminated in Cambodia, India, and Bangladesh. A study in Myanmar showed positive impact of adoption of best practices and machineries on female farmers' livelihoods including nutrition. In West Africa, 109,000 RiceAdvice recommendations were provided with farmers from 2014 to dry season in 2021. Yield increase with RiceAdvice recommendations was on average 15, 16, 10, and 3%, respectively in Burkina Faso, Mali, Nigeria, and Senegal. In Madagascar, the pilot-scale test of the P-dipping technique which is to dip seedling roots into P-enriched slurry at transplanting was implemented in 300 farmers’ fields, and confirmed that this technique increases fertilized P use efficiency by 98%. *Stylosanthes guianensis*, legumes, and vegetables were identified as diversification options in rice-based systems in Africa. Good practices enhanced rice yield and profit in Uruguay.

Detailed Annex:

IRRI

Farming systems analysis (FP3.1)

Assessing challenges to scaling of AWD (Philippines) and Improved water management practices (India, Philippines, Indonesia)

Intensification mechanization (FP3.2)

1. CORIGAP: 783,529 households in 6 countries increased yield: Indonesia (13-90%), China (11%), Myanmar (13%), Sri Lanka (4-20%), Thailand (1%) and Vietnam (8%) and profits from rice farming Indonesia (17-90%), China (21%), Myanmar (30%), Thailand (15%) and Vietnam (28%).

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2. Integrated crop management including mechanization options and IPM were disseminated and increased rice yield in Bangladesh, Cambodia, India, and Vietnam.
3. Scientific evidence and promotion of mechanized transplanting/direct seeding in Vietnam contributed to reduced seed rate by 40-60%, pesticide use by 40-50%, and nitrogen use by 20-30%.
4. Scientific evidence and promotion of mechanized direct seeding (new APV-precise seeder) in Vietnam helped reduce seed rate by 40-60% and nitrogen use by 20-30%.
5. Laser leveling introduced in Thailand and the Philippines and scaled out through cooperation with the private sector.

Farm diversification (FP3.3)

1. Ecological Engineering (EE) using farmer's preferred vegetable crops on the bunds, enables diversified landscape and pest management benefits in Cambodia.
2. Options to diversify rice during wet-season identified and evidence of benefits documented in India.
3. Diversified crops including sunflower, maize introduced and disseminated in rice-based system in Bangladesh.
4. Hybrid rice was promoted to improve rice yields and to bring wheat sowing time on time in rice-wheat systems in India.

AfricaRice

In Rwanda, country-specific good agricultural practices (GAPs) were developed. Large scale GAP demonstration plots were established and 2,000 rice farmers were trained through farmer field days.

Promising crop and nutrient management practices were identified in Ethiopia, Uganda, Tanzania, and Madagascar. In Ethiopia, transplanting instead of direct seeding increased the yield by 18 to 23% (yield increased from 3.8 to 4.4 t/ha) by avoiding the terminal cold induced sterility. P micro-dose placement increased the rooting depth of upland rice that can be beneficial to avoid drought stress in Tanzania and Madagascar. Micro-dose P placement enhanced the deep root section by 22 to 33% with an enhanced P recovery rates (13 to 58%, i.e. 4- to 5-fold) and fertilizer use efficiency (110 to 458 g biomass per g P applied; i.e. 9- to 14-fold) compared to broadcast P. A yield increase of 1 to 1.8 t/ha was observed for micronutrient application under irrigated lowland and rainfed lowland conditions under moisture stress free conditions in Tanzania.

Crop diversification options were jointly tested with farmers in Cote d'Ivoire, Madagascar, Senegal, and promising options were identified together with farmers. In Madagascar, 4 to 5 spp. out of 12 spp. produced considerable yield which is equivalent to a rice yield of 0.5 to 5 t/ha during off-season which is about 13% to 125% increase in farm income per year depending on the vegetable spp. compared to rice

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cultivation alone. In Ivory Coast, the agronomic and economic performances of different off-season crops were assessed from 2019 to 2021 in two lowlands. The off-season crops were tomato, okra, cucumber, zucchini, and green bean. The highest agronomic (yield) and economic (net income) performances were obtained with cucumber and tomato. Agronomic performance and farmers' preference of vegetables and legumes were evaluated in irrigated rice-based farming systems in Senegal. Based on farmers' preference (crop duration and productivity) and agronomic performance in two seasons, 8 promising crops with rice equivalent yield of 12 to 125 t/ha were selected and are currently testing in 30 farmers' fields. Economic analysis showed that rice-tomato and rice-onion rotational systems can increase profit by USD 1211 (97%) and USD 4431 (345%), respectively in comparison with rice-rice systems.

CIAT

CIAT/FLAR and local partners in Uruguay had 15 demonstrations plots on good agronomic practices across all growing regions in this country. We found a 20% yield increase in demonstration plots (10,560 Kg/ha), under improved practices (mainly less seed per area unit, fertilization based on soil analysis, and irrigation management), as compared to the conventional management (9,165 kg/ha).

CIRAD

Data from 4-year experiment comparing different legumes schemes integration of rice bi-annual rotations in Madagascar were analyzed and published. Modelling study showed that green manure improve rice performance, but specific attention has to be paid to the N leaching. A 2-year participatory experiment focusing on trade-offs between social, environmental and economic services showed that upland rice in rotation with sole legume cropping with traditional pulses could be the best options in low input cropping systems.

JIRCAS

Field experiments identified that the *Stylosanthes guianensis* can be a promising cover/relay crop to integrate into the upland rice-based production system in central highlands of Madagascar with high P acquisition capacity from P-deficient soils and improvement of the subsequent upland rice yield. JIRCAS developed and published the user manual for researchers and agricultural extension workers to facilitate climate-smart agriculture in rainfed rice production on their own and at any places.

Relevance to Covid-19:

Due to Covid-19, face-to-face FP3 annual workshop was not planned in 2021. In Asia, Covid-19 has severely disrupted research over the last 10 months. Research has continued but scientists have hardly been able to travel. Field research has been scaled back and/or implemented by local partners. This has largely worked for now but the consequences will not be clear for some time e.g. much research hinges on networks and partnerships and these have become frayed in the last 10 months. They will need to be

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nurtured in the 2022 not least because some partners feel further alienated by a perceived lack of consultation by the CGIAR during the reform process.

AfricaRice couldn't transport the micronutrient fertilizers for the micronutrient omission trials in Nigeria, Rwanda and Madagascar. The planned SRP survey in the highlands of Madagascar was not implemented due to the imposed periodic lockdowns. GAP training in 2021 dry season in Senegal was delayed due to COVID-19.

A pilot-scale testing of promising rice-based cropping system using *Stylosanthes guianensis* or the field validation of WeRise model was not implemented in Madagascar because of the safety measure against COVID-19. Instead, JIRCAS developed and published WeRise manual for researchers and agricultural extension workers so that they can promote the ICT for better practices in rainfed rice production on their own at any place. In addition, the analysis of rhizosphere soils of various leguminous crops grown in a P-deficient field trial led by CIRAD was alternatively progressed with the additional identification of pigeon pea as another P-efficient crop with the capacity to solubilize less-labile P in rhizosphere soils. Likewise, another greenhouse experiment identified several species among *Vigna vexillata* spp. which had high P uptake and biomass production capacity even high P-fixing soils.

F4 - Flagship progress:

A key objective of this Flagship aimed to understand the GxExM relationships to better define ideotypes targeted to environments and GWAS peaks useful for breeding for those environments. Analyses of Global Rice Array (GRA) antenna panel (AP) data for grain yield for 57 genotypes identified 7 main environmental clusters from 21 out of 25 sites. Grain yield variability was explained by abiotic and biotic stresses and sensor varieties were selected for breeding programs. Besides, reference panel analyses have identified GWAS peaks that show varying degrees of environment specificity. UAV based phenotyping methods for measuring biomass, greenness, height, and phenology measurements have been optimized across centers; data analysis pipelines and database for UAV images have been developed. Surveys for pathogen diversity and distribution (blast, bacterial blight, viruses, others) have enabled development of molecular tools for identification; application of the markers in PathoTracer has enabled effective monitoring and early season disease diagnosis. An updated project website was launched that includes a datastore for GRA results; new tools and improved documentation were added to Crop Galaxy.

Detailed Annex:

AMMI analyses of the AP data identified 8 clusters sites with climate and or disease constraints and germplasm was used as sensor of the environment. For example, Giza 178 (a heat tolerant variety) was the best performer in Group 1 with low radiation, high night temperature, and no disease. Also we observed a lack of tolerance to abiotic stress in high yielding varieties, all the high yielding varieties clustered together in Group 7 with high yielding environments but showed the largest yield decrease

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(50%) across environments. This suggested that high yielding varieties doesn't have the tolerance to different biotic/abiotic stresses hence breeders should introduce this resistance as a climate change adaptation strategy.

UAV collaboration on the global rice array was extended to partners at the Taiwan Agricultural Research Institute. An implementation of the Breedbase (Imagebreed) database was adopted for UAV image and analysis and data.

New surveys of pathogen diversity were undertaken for sheath blight and brown spot, and metagenome methods were applied to detect novel viruses in a survey from Burkina Faso.

An updated project website was developed for Flagship results: <https://sites.google.com/irri.org/globalricearray/home>.

Training on tools for GWAS analyses was accomplished in two courses, introductory and advanced SNPs to GWAS, for 45 trainees from NARES, National Universities, and advanced research institutes,

Relevance to Covid-19:

The limitations of travel imposed by COVID meant that planned on site training activities for UAV were cancelled. Focus was moved to analysis of panel trials and interpretation in preparation for publication.

F5 - Flagship progress:

Despite all the challenges and constraints posed by the Covid-19 pandemic, progress has been made in all clusters of activities. Foundation for high quality rice breeding has been established to address challenges related to climate change in the years to come. The establishment of a dedicated DSR breeding program, market segmentation, and product concepts are critical for rice breeding effort in the future. In line with the expectations on creating market demanded varieties and rapid varietal turn-around, leading to increased genetic gains, the OneRice initiative has adopted an end-to-end framework. The current breeding programs have a shorter breeding cycle, centralized pre-breeding, improved breeding and on-farm trialing network, and a close interaction with NARES partners. Deployment of many genes has progressed, and several new genes brought to completion. To better define the cooking and eating quality (CEQ) of rice varieties, new models are established and used as a detailed selection tool for screening of a variety that can be included as selection criteria in the breeding programs to cater the needs of both farmers and consumers. New methods to analyze on-farm trial data, breeding schemes and index of selection have been developed as part of the unification of breeding analytics pipeline.

Detailed Annex:

FP5.1 Use of genetic diversity continued to prove useful to identify novel donors and genes for traits of interest in breeding. New information was published on grain arsenic, cadmium uptake, nitrogen deficiency, reproductive stage salt tolerance among other traits. Further studies were published regarding

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grain Zn and Fe, anaerobic germination, drought, and blast. These studies provide evidence for their future (or ongoing) uptake by breeders.

FP 5.2 Deployment of many genes has progressed, and several new genes brought to completion, including new genes for RYMV and BPH resistance. Phenotypic evaluation of completed products has commenced. Seed has been distributed to IRRI breeding programs, as well as partners in Bangladesh and Africa.

FP5.3 In line with the expectations on creating market demanded varieties and rapid varietal turn-around, leading to increased genetic gains, IRRI's breeding programs through OneRice have adopted an end-to-end framework. The current breeding programs have a shorter breeding cycle, centralized pre-breeding, improved breeding and on-farm trialing network, and a close interaction with NARES partners.

FP5.4 has been one of the most active CoAs in the area of climate change. The activities targeted through this CoA have laid the foundation for high quality rice breeding to address challenges related to climate change in the years to come. In particular, the establishment of a dedicated DSR breeding program, market segmentation, and product concepts are critical for rice breeding effort in the years to come. FP5.5 To define the cooking and eating quality (CEQ), the pasting properties in combination with starch properties were used to develop two layered models in order to classify the rice varieties into twelve distinct CEQ ideotypes with unique sensory profiles. We conducted random forest modeling using 1.8 million high density SNPs and identified top 1000 SNP features which explained CEQ model classification with the accuracy of 0.81. Results of this study have shown that the RVA properties and starch structure properties can be utilized to distinguish 12 CEQ ideotypes with different sensory textural profiles. These models can be used as a detailed selection tool for screening of a variety that can be included as selection criteria in the breeding programs to cater the needs of both farmers and consumers. To breed low glycemic index (GI) rice varieties, we have defined the genetics and identified two IRRI breeding lines IRRI 162 and IRRI 163 with GI of 55 and 57, respectively, with yield of 6.40 tons/ha and 6.9 tons/ha. In addition, advanced RILs with elevated amylose (more than 30%) with low GI (median of 38) exhibit good yield potential was developed.

FP5.6 optimized the on-farm trials in NARES reducing the number of trials and better allocating the trials, developed a new way/method to analyze on-farm trial data, worked on the unification of breeding analytics pipeline, and - based on simulations - developed new breeding schemes and index of selection.

JIRCAS

FP5.1 Selected donors for tolerance to Fe toxicity in West-Africa among interspecific *O. sativa* x *O. glaberrima* lines of a QTL mapping population. Donors have been shared with counterparts in Madagascar for confirmation of tolerance and initiation of breeding populations in crosses with local varieties.

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FP5.2 Developed Genomic Selection models for the 3K SNP-Seek set for 1) grain Zn concentrations and 2) yield under low-fertility conditions in Madagascar and showed that a GP approach is suitable for identifying new donors. As a result five donors have been utilized in the development of new breeding populations (2021).

FP5.3 (2021) 1) Completion of the development of IR 64 NILs for partial blast resistance genes; pi21(BC5F5), Pi35(BC2F5), and Pb1(BC6F5). 2) NILs in the genetic background of IR 64 and Sahel108 having introgressed the actpk1 gene that increases ammonia uptake were evaluated under irrigated conditions. Grain yield increased by 11 to 17% in Sahel108-NILs.

FP5.4 2 potential upland rice varieties with 15 - 20% reduction in yield loss caused by low soil fertility in smallholder farms developed and tested in farmer's fields (so the varieties are 15% and 20% better compared to a local variety under low-input management. Variety release proceedings are ongoing together with Malagasy counterpart organization FOFIFA but are delayed due to COVID-lockdown during the crucial reproductive stage inspection period. (2) We also developed 2 new lowland varieties and these shall be released officially on Nov 4.

Relevance to Covid-19:

Mitigation measures in the form of automated watering systems were developed and installed which prevented further loss of germplasm when new lockdowns were imposed. Centrally consolidated planning of research operations and manpower pooling was conducted to deliver activities on time. Mechanized direct seeding targeted was implemented to help address availability of manual labor in breeding operations and commercial cultivation. This has been one of the major issues in the COVID19 era and requires a paradigm shift to address it permanently. Healthier rice, rice with low glycemic index and high Zinc content became even more important to achieve nutritious diet during this pandemic period.

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

A) Have any promising research areas been significantly expanded?

There has been an increasing demand for better understanding the impact of the COVID pandemic on the rice value chain in Asia and Africa. New research studies were initiated to inform policies makers in various countries. These studies were funded through bilateral projects and in some cases, RICE was used as complement.

Research on food choice and nutrition was significantly expanded as a result of the CGIAR's changing focus. The role of cereals on global food security is widely debated. To provide clarity in this debate, FP2 published an important study on the determinants of the global burden of chronic and hidden hunger,

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which suggests that cereals continue to play a crucial role in global food security. The study is currently being used by various One CGIAR Initiatives.

The breeding network across Asia and Africa has expanded significantly, with an increased number of partners by approximately three times. Phenotypic evaluation of completed deployment products for blast and bacterial leaf blight resistance, amongst others, has commenced and field trial evaluations are also underway. The extent of direct seeded rice planting has been expanded significantly. Cooking and eating models to predict quality in hybrid rice has been expanded through public-private initiatives.

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

With the budget limitation and the mobility constraints imposed by the COVID pandemic, research lines under RICE FP 1 on seed systems and collective innovations were moderately reduced. However, we were able to create some synergy on some studies with on-going bilateral projects like the Cereal System Initiative for South Asia (CSISA) and AGGri-Alliance in Asia.

Because of the mobility restrictions imposed with the COVID pandemic, the study on the impact of stress-tolerant rice varieties will only focus on Bangladesh.

A pilot-scale test for promising rice-based cropping system using *Stylosanthes guianensis* was not implemented in Madagascar because of the safety measure against COVID-19.

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

No changes in research area in the last year of the CRP

1.2.4 Altmetric and Publication highlights (max. 400 words)

Sustainable intensification for a larger global rice bowl, *Nature Communications*, 2021, 12:7163 (<https://doi.org/10.1038/s41467-021-27424-z>), Shen Yuan, Bruce A. Linqvist, Lloyd T. Wilson, Kenneth G. Cassman, Alexander M. Stuart, Valerien Pede, Berta Miro, Kazuki Saito, Nurwulan Agustiani, Vina Eka Aristya, Leonardus Y. Krisnadi, Alencar Junior Zanon, Alexandre Bryan Heinemann, Gonzalo Carracelas, Nataraja Subash, Pothula S. Brahmanand, Tao Li, Shaobing Peng, Patricio Grassini.

Future rice systems must produce more grain while minimizing the negative environmental impacts. A key question is how to orient agricultural research and development pro-grams at national to global scales to maximize the return on investment. Here we assess yield gap and resource-use efficiency (including water, pesticides, nitrogen, labor, energy, and associated global warming potential) across 32 rice cropping systems covering half of global rice harvested area. We show that achieving high yields and

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high resource-use efficiencies are not conflicting goals. Most cropping systems have room for increasing yield, resource-use efficiency, or both. In aggregate, current total rice production could be increased by 32%, and excess nitrogen almost eliminated, by focusing on a relatively small number of cropping systems with either large yield gaps or poor resource-use efficiencies. This study provides essential strategic insight on yield gap and resource-use efficiency for prioritizing national and global agricultural RD investments to ensure adequate rice supply while minimizing negative environmental impact in coming decades.

The global assessment was led by Huazhong Agricultural University and University of Nebraska-Lincoln, in collaboration with partners from other 11 institutions, including U.C Davis Texas AM AgriLife Research Center in USA, the International Rice Research Institute (IRRI), Africa Rice Center, the Indonesian Center for Rice Research (BB Padi) Assessment Institute of Agricultural Technology (AIAT) in Indonesia, Federal University of Santa Maria EMBRAPA Arroz e Feijão in Brazil, the National Institute of Agricultural Research (INIA) in Uruguay, and the Indian Institute of Farming Systems Research (ICAR) Indian Institute of Water Management in India. The study assessed rice yields and efficiency in the use of water, fertilizer, pesticides, and labor across 32 rice cropping systems that accounted for half of global rice harvested area.

“This study is the most comprehensive global evaluation of production systems for a major staple crop that I am aware of, and it will set the standard for future global comparison of such systems,” said Kenneth G. Cassman, professor emeritus at Nebraska.

Nature Sustainability Community:

<https://sustainabilitycommunity.springernature.com/amp/posts/a-roadmap-for-securing-a-larger-and-greener-global-rice-bowl>

UNL News: <https://news.unl.edu/newsrooms/today/article/researchers-analyze-roadmaps-toward-larger-greener-global-rice-bowl/>

1.3 Cross-cutting dimensions (at CRP level)

1.3.1 Gender (max. 750 words)

A) List any important CRP research findings

Gender-disaggregated data of socioeconomic surveys of farm households on technology needs, technology performance in farmers' fields, and adoption constraints were analyzed. Findings are presented in reports and peer-reviewed journals

In Cote d'Ivoire and Madagascar empowering the rural women not only make them economically empowered but also help them to get credit for productive work. In Nigeria, it is possible for women to run profitable businesses, but some constraints remain: lack of awareness, skills, capital, basic business tools/equipment, and the perception of gender-specific nature of some activities. Within the COVID19

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context, production kits were provided to vulnerable women to facilitate their access to inputs and enhance their resilience.

Demand for rice fragrance in seven countries across South and Southeast Asia (Bangladesh, India, Cambodia, Indonesia, Philippines, Thailand, Vietnam) is found to be mainly driven by women. Although preferences for aromatic rice were found to significantly drive consumer demand for packaged rice in India and Thailand in a follow-up study, no statistically significant differences between male and female rice consumers was found, suggesting both genders play an equal role in driving demand for packaged rice.

In a study on consumer demand for traditional heirloom rice varieties in the Philippines, we find that women are willing to pay more for heirloom rice and can play a role in boosting demand for heritage crops. In a consumer study in Benin, we find that women are willing to pay price premiums for improved parboiled rice, which suggests the GEM and mini-GEM parboilers enable women processors to capture price premiums on the market and improve their livelihoods.

We assessed gendered performance of rice cultivation and access to productive resources (land, training, inputs (fertilizers, seeds...), which remains the key consideration to further enhance women's participation in rice farming in Madagascar highlands. The adoption levels of good agricultural practices (GAPs) in Madagascar show that men are significantly more familiar with the key GAPs and are more likely to practice them. The stochastic frontier production function model showed that female rice farmers are more efficient than male farmers. Their efficiency could be further enhanced with facilitating access to (i) input such as improved variety, fertilizer, (2) land ownership, (3) mechanization for instance to facilitate weeding, and (4) training.

Gender-responsive Customer profiles (which define and validate the demographic, behavioral and geographic attributes of a target segment) that are economically significant have been reviewed.

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

Accounting for gender considerations is absolutely crucial in the development of product profiling. Gender considerations should support new breeding programs in Africa, Asia and Latin America with inputs on the preferences of female farmers and other actors for certain attributes of rice.

The establishment of baseline measures on women empowerment is important as it serves as benchmark measures against which gender-related impacts will be measured in ex-post impact assessment.

Gender-disaggregated preferences and evidence of gender-driven demand are not telling the whole story. We need to generate a deeper understanding of gender in product upgrading. FP2 was instrumental in the development of the new CGIAR Initiative on Market Intelligence and Product Profiling. More specifically, a work package was designed to develop an institutional innovation to help CGIAR and

NARES develop gender-intentional product profiles, which is expected to generate new insights into how breeding can contribute to gender equity and inclusiveness.

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

Rather the opposite. Thanks to strong donor push, social science and gender research is increasingly recognized by plant breeders, which has now materialized in the new CGIAR Initiative on Market Intelligence and Product Profiling.

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

Within the PEJERIZ project, 40 and 38 youth individual and group agripreneurs benefited from the implementation of coaching and mentoring in addition to the many training sessions provided, respectively, in Senegal and Mali, This made it possible to support young people in defining and setting up their business plan and in obtaining bank loans. Indeed, the support of young agripreneurs has made it possible to establish a relationship between banks and young people in Mali and Senegal for young people who previously could not obtain loans from financial institutions.

AfricaRice closely works with youth service providers for scaling of RiceAdvice. In 2021, 76% of service providers are youth (241 youths) in Nigeria. They were mainly identified by farming groups. In Burkina Faso, 47% are youth. All of them are public extension agents. First, we find that income largely conditions consumer demand for packaged rice and certified rice. We propose policy guidelines for fostering inclusiveness in rice value chain upgrading strategies (<https://doi.org/10.1016/j.gfs.2021.100491>, <https://doi.org/10.1016/j.foodcont.2021.10826>). Secondly, to support indigenous communities in the Cordillera Autonomous Region (CAR) and preserve rice cultural heritage in the Philippines, a consumer survey was conducted in Metro Manila to develop a segmented marketing strategy for heritage farming. Findings indicate proper information framing will be necessary to create demand and support the valorization of heirloom rice to preserve cultural heritage of indigenous communities and in situ biodiversity of rice landraces in the Philippines (<https://doi.org/10.1007/s10460-020-10159-w>). Thirdly, to support rice breeding programs in their efforts to tailor varieties to local communities in Africa, two new studies were conducted on the role of cultural heritage and indigenous communities' genealogical lineages to ancient rice domesticators in the Senegambia. The insights generated by these studies have important implications for breeding, post-harvest and value chain upgrading strategies in the region.

A) List any important CRP research findings

agCelerant™ is a multiservice digital tool developed by Manobi Africa that aims to better orchestrate the rice value chain by derisking the transactions and engaging the private sector and the financial services. The youth are trained and provided with smartphones and motorbikes to provide paid services to farmers

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and other stakeholders. The youth activities include the registration of farmers, geo-referencing, data collection (crop calendar, input needs, on-farm management, production, available stock, etc.), and facilitation of their transactions with their customers and suppliers (orders, delivery, invoicing, collection, etc.).

Rice value chain upgrading strategies are not necessarily inclusive. Special efforts need to be devoted to render them more inclusive towards indigenous communities and low-income consumers. Policy makers can do this by creating an enabling environment for private sector development in rice value chain upgrading and by supporting information campaigns that inform consumers on the benefits of consuming local. In West Africa, it is important to account for rice cultural heritage in breeding strategies. It was found that rice consumers with genealogical ties to the original domesticators of rice in the Senegambia tend to prefer characteristics reminiscent of *Oriza glaberrima*. This suggests that breeders need to find a compromise in satisfying preferences for both import-induced Asian rice traits and cultural heritage-induced African rice traits. These insights have never been reported before and can represent a breakthrough with respect to market segmentation and product profiling.

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

The willingness to be involved in agriculture varies across region and gender, with the high readiness of female youths signaling a feminization in agriculture. Involvement in value chain activities has a significant and positive impact on career choice. Youth policy needs to address the different preferences and facilitation requirements of male and female youth, in order to change youth's aspiration and be inclusive of both genders.

Since FP2's first output on inclusiveness of rice value chain upgrading at farm level in 2019 (<https://doi.org/10.1016/j.landusepol.2019.104...>), it redirected some of its consumer work towards inclusiveness as well (<https://doi.org/10.1016/j.gfs.2021.100491>, <https://doi.org/10.1016/j.foodcont.2021.10826...>). Since its discovery of the "cultural heritage hypothesis" in 2017 (<http://dx.doi.org/10.1016/j.worlddev.2017.04...>), FP2 has started to reinterpret previously collected datasets to validate the hypothesis and develop recommendations for breeding, post-harvest and value chain upgrading strategies (<https://doi.org/10.1093/qopen/qaab014>, <https://doi.org/10.1177/00307270211019758>).

Through new initiative development, we learned about adaptive transformation that tackles the root causes of vulnerability, and sheds light on relations of power around social equity. However, it is too late to be incorporated into the CRP. The learnings will feed into new Initiatives.

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

There was no problem in relation to youth issues or integrating youth into the CRP 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 still managed to provide short-term capacity development to 43,360 participants, of which 33% 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 232 scholars (38% female) were enrolled in long-term capacity development (BSc, masters, PhD, interns and on-the-job-trainees).

In Rwanda, 2,000 rice farmers were trained in GAP through farmer field days. In Senegal, a total of 575 farmers including 162 women were trained on applying good agricultural practices for sustainable rice production over three years. A total of 316 service providers and extension agents were trained in use of RiceAdvce in Nigeria and 15 in Burkina Faso.

In Africa, major capacity development programs were organized around the fabrication, testing, validation, piloting and standardization of the GEM and Mini GEM parboilers (Benin, Cote d'Ivoire, Niger, Nigeria, Togo, Cameroon, Mali, Nigeria and Senegal) with private and public sector partners.

Joint capacity development program for interdisciplinary teams in 7 Key NARES in SA and SSA on development of gender-responsive, market-driven product concept development was initiated. IRRI conducted a joint capacity building on gender-responsive plant breeding, together with the Uganda-based Gender-responsive Researchers Equipped for Agricultural Transformation team, for IRRI and NARES partners in Bangladesh, India, Nepal and the Philippines. The [course report](#) and a [media article](#) related to the course were prepared for review. Capacity development program served as an example for the development of the Genetic Innovation for Impact Learning Alliance in Work Package 5 of the new CGIAR Market Intelligence and Product Profiling Initiative.

1.3.4 Climate Change

A study shows that strategies to adapt to climate change adaptations vary depending on which stresses individuals are exposed to. At the household level, droughts and floods have the strongest effect on climate change adaptation. However, adaptations at the agricultural level depend more on the impacts of the stress and less on the climatic stress itself. Understanding what climatic stresses are already eliciting a response, and what adaptations are being used by individuals, is invaluable for designing successful climate change policies. This understanding can also help policy makers identify where gaps exist in individual climate change adaptations and fill these gaps with a public response.

Intersectoral upgrading of rice value chains through the development of novel rice straw management

practices and markets for rice straw is the area where rice value chain upgrading can contribute most to climate change mitigation. Little is known about what it would take for farmers to stop straw burning. Through choice experiments with 543 Vietnamese farmers in the Mekong Delta, we estimated that farmers are willing to stop straw burning and adopt sustainable straw management practices in return for monetary incentives in the range of US\$157–229/ha. Policy makers can use these results to design optimal policies for mitigating air pollution by diverting farmers away from straw burning towards sustainable rice straw management practices (<https://grispnetwork.groupsie.com/files/1039...>).

Analyses of the Global Rice Array Antenna Panel (AP) have enabled the classification of environments across sites and the GxE interactions within and across sites. The AP analyses allow selection germplasm types to target to environment categories. Analyses of reference panel data including GWAS are identifying peaks influenced in varying degrees to the environment - i.e. there are significant peaks with broader stability across environments and ones that are environment specific.

2. Effectiveness and Efficiency

2.1 Management and governance (max. 300 words)

No changes in management and governance structure. The two new DDG-Rs for AfricaRice and IRRI took up their management roles in the RICE Program Planning and Management Team. Because of Covid-19, and 2021 being the last year of the CRPs, no face-to-face meeting of the Independent Steering Committee (ISC) was held. On November 18, a close-out webinar among RICE staff (from all participating centers) and with the ISC was organized.

2.2 Partnerships

2.2.1. Highlights of External Partnerships (300 words)

As 2021 was the last year of the CRPs, no new large partnerships were entered into. Table 8 lists a few key large partnerships that were active over the last few years and will continue to be important partnerships for the OneCGIAR. Some partnerships have over 100 members and hence they have not all been entered in the list of partners. A number of partnerships straddle across RICE flagship projects but have been submitted under only one (eg FLAR is listed under FP5 but also operates on policies (FP1) and crop management (FP3)).

2.2.2. Cross-CGIAR Partnerships (300 words)

Cross-CGIAR partnerships continued to focus on the platform Excellence in Breeding (EiB), the Gender platform, the Genebank Platform, the new initiative Excellence in Agronomy, and on the CRPs Policies,

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Institutions, and Markets (PIM), CCAFS, and Agriculture for Health and Nutrition (A4HN). 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. Collaboration with some of these platforms and/or CRPs also took the shape of developing new post-CRP initiatives through participation of RICE staff in various Initiative Design Teams.

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)

Because of covid-19, a number of MELIA activities that relied on data collection in the field or face-to-face meetings, were canceled. Nevertheless, a large number of MELIA activities were still able to continue through local outsourcing of such activities, and through the use of digital data collection tools and mechanisms. Details and highlight results are found in Table 10.

2.5 Efficiency (max. 250 words)

No major new efficiency gains were made in the last year of the CRP.

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

Contextual: Covid-19.

The major expected impact of COVID-19 is that continued lockdowns severely affected the productivity of staff, particularly families with small children. A second major impact were the continued the travel restrictions, which seriously hampered execution of field work. To mitigate this constraint, surveys were as much as possible outsourced to local research firms. Secondly, we developed alternative interventions such as e-learning, e-technical assistances, etc. to reach the country partners. Web-based communications are such that planned meetings and workshops have taken place remotely. While it is hard to build social capital on remote calls, there has been much progress. Some surveys have had to be postponed due to restrictions on movement but many of these will take place as movement restrictions are lifted Also, we consolidated a few project sites; Eg, FP2 focused on the Philippines and Vietnam, where locally-based scientists could travel conduct the experiments and on-site activities. in FP3, due to COVID 19 related mobility restrictions, we couldn't transport the micronutrient fertilizers from Kenya for the micronutrient omission trials in Nigeria, Rwanda and Madagascar. In Rwanda, instead, nutrient omission trials were conducted.

Institutional: OneCGIAR reform.

The reform processes towards OneCGIAR have taken a lot of energy and time from scientists. Especially the participation in various working groups, and the development of the new Initiatives, considerably diverted scientists' and support staff's time away from RICE. Also, the perceived lack of appreciation at the top of OneCGIAR management for the work of CRPs negatively affected staff motivation.

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. However, as 2021 was the last year of RICE, a number of long-term initiatives - such as the Global Rice Array - face an uncertain future and may not continue beyond 2021.

Quite some W1,2-funded staff time was spent on the OneCGIAR transformation process. Staff contributed to numerous work and advisory groups (eg DWGs), and the Initiative Development Teams. Especially the development of new Initiatives consumed a considerable amount of staff time - which did not directly contribute to RICE outputs.

Selected examples in Table 12 provide some details of activities across the RICE Flagship Projects supported with W1,2 funds.

3. Financial Summary

At the time of writing (February 2022), no audited financial statements are available yet for 2021. The 'Forecast 2020' is actually based on audited financial reports from 2020. Compared with 2020, the line items for consultancy, travel, operations, collaborators and partners, and capital equipment are slightly higher in 2022 because of a small increase in total W1,2 funding in 2022.

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
<p>1.1 ADOPTION: 100 million more farm households have adopted improved varieties, breeds, trees, and/or improved management practices.</p>	<p>The promotion of the improved rice management package '1 Must Do-5 Reductions' (1M5R); based on the earlier 3R3G package) was reached by 104,448 smallholder rice farmers and adopted on 114 thousand ha in the Mekong River Delta of Vietnam. Flor, R.J.; Tuan, L.A.; Hung, N.V.; My Phung, N.T.; Connor, M.; Stuart, A.M.; Sander, B.O.; Wehmeyer, H.; Cao, B.T.; Tchale, H.; et al. Unpacking the Processes that Catalyzed the Adoption of Best Management Practices for Lowland Irrigated Rice in the Mekong Delta. <i>Agronomy</i> 2021, 11, 1707. https://doi.org/10.3390/agronomy11091707 Connor, M., , H. Sustainable rice production in the Mekong River Delta: Factors influencing farmers’ adoption of the integrated technology package “One Must Do, Five Reductions” (1M5R). <i>Outlook Agric.</i> 2021, 50, 90–104; https://doi.org/10.1177/0030727020960165</p>	<p>According to the AR template for 2021, this field is no longer required</p>	<p>•Geographic Scope: National. •Countries: The Socialist Republic of Viet Nam.</p>
	<p>Over 780,000 farm households in South-East and East Asia adopt improved rice management practices (such as 'Three Controls', Site-Specific Nutrient Management' '1 Must Do - 5 Reductions', Integrated Pest Management; Good Agricultural Practices. CORIGAP end of project report, IRRI, 2021; https://grispsnetwork.groupsites.com/files/1035830</p>	<p>According to the AR template for 2021, this field is no longer required</p>	<p>•Geographic Scope: Multi-national. •Countries: China, Indonesia, Sri Lanka, Myanmar, Thailand, The Socialist Republic of Viet Nam.</p>
	<p>A significant share of households in salinity-prone areas of the Mekong River Delta in Vietnam actively adopt salt-tolerant varieties developed by the RICE/IRRI Consortium for Unfavorable Environments (CURE). Almost half of all fields are planted with a CURE-related variety in either the pre-salinity surge Dong Xuan season or the post-salinity surge He Thu season. Areas planted under CURE-related varieties are extrapolated based on field</p>	<p>According to the AR template for 2021, this field is no longer</p>	<p>•Geographic Scope: National. •Countries: The Socialist Republic</p>

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	<p>adoption rates and total planting area district data: for the Dong Xuan season around 195,000 hectares are under CURE-related varieties, and for the He Thu season, 239,000 hectares. With average farm sizes of 1.5 ha, the number adopting farm households are estimated to be 130,000 in the Dong Xuan season and 159,000 in the He Thu season. Salt-tolerant rice variety adoption in the Mekong River Delta: Farmer adaptation to sea-level rise SongYi Paik, Dung Thi Phuong Le, Lien Thi Nhu, Bradford Franklin Mills, PLOS-ONE; https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0229464; https://doi.org/10.1371/journal.pone.0229464</p>	required	of Viet Nam.
	<p>MAG-18 is an improved rice variety developed by CIAT/FLAR and released in Bolivia in 2008. Within six years of its release, it had been adopted by one out of every four Bolivian rice producers. Currently, the variety is the most planted, representing 58% of the total area produced, both in rainfed and irrigated systems. It's good adaptation in different production systems and its high grain quality have resulted in a popular reception by both producers and the industry. Furthermore, for smallholders, the adoption of this variety has increased the adoption-likelihood for other improved management decisions, such as fertilizer use and land mechanization, as well as to having access to a more significant market share in terms of rice volumes sold. Martinez, J. M., Labarta, R. A., Gonzalez, C., & Lopera, D. C. (2021). Joint adoption of rice technologies among Bolivian farmers. <i>Agricultural and Resource Economics Review</i>, 50(2), 252-272. https://doi.org/10.1017/AGE.2021.9</p>	According to the AR template for 2021, this field is no longer required	•Geographic Scope: National. •Countries: Bolivia.
	<p>In Ecuador, FLAR, with the Alliance as a strategic partner, and its partners INIAP and PRONACA, developed and released the improved SENACA FL09 and SENACA FL11 rice varieties in 2009 and 2011, respectively. In 2014, SFL 09 was used by 1 in 3 producers, while, in 2019 SFL11 occupied 61% of the sown area. According to the producers who used these varieties, one of the reasons for planting them was the high commercial demand, being preferred by the industry. Marin-Salazar D; Andrade-Lopez RS; Labarta RA; Twyman J. 2018a. Participacion de la mujer en las decisiones sobre el uso y la intensidad de siembra de variedades de arroz en Ecuador: Women's participation in decisions about rice variety use and intensity in Ecuador. <i>Cuestiones Economicas</i> 28:119-146. https://hdl.handle.net/10568/98378</p>	According to the AR template for 2021, this field is no longer required	•Geographic Scope: National. •Countries: Ecuador.
	<p>In Colombia, in 2013, the Alliance of Bioversity-CIAT and Fedearroz, Fenalce, and the Ministry of Agricultural and Rural Development initiated technical and scientific cooperation to increase the federations' capacity to identify potential agricultural threats from climate change and to develop management options. In 2020, digital agriculture tools have reached 24% of rice and maize producers (around 4,000 ha), increasing 2020 yields by 26% on average (41% maize, 12% rice). Andrade, R., Ibarra, L., Ortega, J. (2021). Too Little, too late? Rice production to mitigate climate change in Colombia. Colombia. Alliance Bioversity-CIAT. Cali, Colombia (mimeo) Gallego, J., Wiesner, D., Jerez, K., Betancourth, A., Ortega, J., Bateman, A., González, C., Andrade, R., Ibarra, L., Álvarez, A., Cubillos, N. (2021). Evaluación de Impacto Informe final: resultados y recomendaciones. INSUCO.</p>	According to the AR template for 2021, this field is no longer required	•Geographic Scope: National. •Countries: Colombia.

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	CIAT. GCF		
1.2 EXIT POVERTY: 30 million people, of which 50% are women, assisted to exit poverty	After five years of the adoption of the improved rice management package '1 Must Do-5 Reductions' (1M5R); based on the earlier 3R3G package) on 114 thousand ha in the Mekong River Delta of Vietnam, resulted in 19-36% higher income by smallholder rice farmers, across different provinces. Flor, R.J.; Tuan, L.A.; Hung, N.V.; My Phung, N.T.; Connor, M.; Stuart, A.M.; Sander, B.O.; Wehmeyer, H.; Cao, B.T.; Tchale, H.; et al. Unpacking the Processes that Catalyzed the Adoption of Best Management Practices for Lowland Irrigated Rice in the Mekong Delta. <i>Agronomy</i> 2021, 11, 1707. https://doi.org/10.3390/agronomy11091707 Connor, M., , H. Sustainable rice production in the Mekong River Delta: Factors influencing farmers' adoption of the integrated technology package "One Must Do, Five Reductions" (1M5R). <i>Outlook Agric.</i> 2021, 50, 90–104; https://doi.org/10.1177/0030727020960165	According to the AR template for 2021, this field is no longer required	•Geographic Scope: National. •Countries: The Socialist Republic of Viet Nam.
	A meta-analysis compared Site Specific Nutrient Management (SSNM) with farmers' fertilizer practice for maize, rice and wheat using 61 published papers across 11 countries. Relative to the farmer practice, across the crops maize, rice and wheat, SSNM increased profitability by 15%. Pauline Chivenge, Kazuki Saito, Michelle Anne Bunquin, Sheetal Sharma and Achim Dobermann (2021). "Co-benefits of nutrient management tailored to smallholder agriculture" <i>Global Food Security</i> 30 (2021) 100570. https://www.sciencedirect.com/science/article/pii/S221191242100078X	According to the AR template for 2021, this field is no longer required	•Geographic Scope: Multi-national. •Countries: Bangladesh, Burkina Faso, China, Ghana, Indonesia, India, Nepal, Philippines, Senegal, Thailand, The Socialist Republic of Viet Nam.
	From the cultivation of the flood-tolerant rice variety SS1, households in Assam, Odisha and West Bengal in India gained an additional income 67-134 \$/ha. Information quality, adoption of climate-smart varieties and their economic impact in flood-risk areas Published online by Cambridge University Press: 03 July 2020; https://doi.org/10.1017/S1355770X20000212	According to the AR template for 2021, this field is no longer required	•Geographic Scope: National. •Countries: India.
	The adoption of submergence-tolerant rice varieties in northern Bangladesh increased farmers' profit by 55%. Bairagi et al. (2021). Flood-tolerant rice improves climate resilience, profitability, and household consumption in Bangladesh. <i>Food Policy</i> xxxx; https://www.journals.elsevier.com/food-policy	According to the AR template for 2021, this field is no longer required	•Geographic Scope: National. •Countries: Bangladesh.

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	780,000 farmers reached by the CORIGAP project in South-East and East Asia, resulting in a mean increase in income of 15-90% because of increased yield and reduced input costs. From selected case studies: In Can Tho Vietnam, farmers reported an increase in added revenue of USD 271/ha and USD 290/ha in the dry and wet seasons, respectively. In Thailand, farmers reported an increase in added revenue of USD 359/ha to USD 458/ha in the dry and wet seasons, respectively. In Yogyakarta, Indonesia, farmers reported an increase in added revenue of USD 203/ha and USD 254/ha in the dry and wet seasons, respectively. CORIGAP end of project report, IRRI, 2021; https://grisnetwork.groupsites.com/files/1035830	According to the AR template for 2021, this field is no longer required	<ul style="list-style-type: none"> •Geographic Scope: Multi-national. •Countries: China, Indonesia, Sri Lanka, Myanmar, Thailand, The Socialist Republic of Viet Nam.
	Households with farming contracts in Benin increased their market participation by selling 35 percentage points more of their rice harvest, a 140 percent increase above farmers without contracts. This increased land size, higher productivity, and greater market participation resulted in treated households earning \$140 more income per capita, an increase of 230 percent Aminou Arouna, Jeffrey D. Michler, Jourdain C. Lokossou, 2021. Contract farming and rural transformation: Evidence from a field experiment in Benin. Journal of Development Economics, Volume 151, June 2021, 102626. https://doi.org/10.1016/j.jdeveco.2021.102626	According to the AR template for 2021, this field is no longer required	<ul style="list-style-type: none"> •Geographic Scope: National. •Countries: Benin.
2.1 YIELD INCREASE: Improve the rate of yield increase for major food staples from current < 1% to 1.2-1.5% per year	A meta-analysis compared Site Specific Nutrient Management (SSNM) with farmers' fertilizer practice for maize, rice and wheat using 61 published papers across 11 countries. Relative to the farmer practice, across the crops maize, rice and wheat, SSNM increased grain yield by 12%. Pauline Chivenge, Kazuki Saito, Michelle Anne Bunquin, Sheetal Sharma and Achim Dobermann (2021). "Co-benefits of nutrient management tailored to smallholder agriculture" Global Food Security 30 (2021) 100570. https://www.sciencedirect.com/science/article/pii/S221191242100078X	According to the AR template for 2021, this field is no longer required	<ul style="list-style-type: none"> •Geographic Scope: Multi-national. •Countries: Bangladesh, Burkina Faso, China, Ghana, Indonesia, India, Nepal, Philippines, Senegal, Thailand, The Socialist Republic of Viet Nam.
	From the cultivation of the flood-tolerant rice variety SS1, households in Assam, Odisha and West Bengal in India gained an additional yield of 527-1,023 kg/ha. Information quality, adoption of climate-smart varieties and their economic impact in flood-risk areas Published online by Cambridge University Press: 03 July 2020; https://doi.org/10.1017/S1355770X20000212	According to the AR template for 2021, this field is no longer required	<ul style="list-style-type: none"> •Geographic Scope: National. •Countries: India.
	The adoption of submergence-tolerant rice varieties in northern Bangladesh increased yield by 6%. Bairagi et al. (2021). Flood-tolerant rice improves climate resilience, profitability, and household consumption in Bangladesh. Food Policy xxx; https://www.journals.elsevier.com/food-policy	According to the AR template for 2021, this field is no longer required	<ul style="list-style-type: none"> •Geographic Scope: National. •Countries: Bangladesh.

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		required	
	780,000 farmers reached by the CORIGAP project in South-East and East Asia, resulting in a mean increase in income of 15-90% because of increased yield and reduced input costs. From selected case studies: In Can Tho Vietnam, farmers reported an increase in yield of 1089 kg/ha in the dry season and 1274 kg/ha in the wet season; In Thailand, farmers reported an increase in yield of 1503 kg/ha in the dry season and 1919 kg/ha in the wet season; In Yogyakarta, Indonesia, farmers reported an increase in yield of 739 kg/ha in the dry season and 1189 kg/ha in the wet season. CORIGAP end of project report, IRRI, 2021; https://grispsnetwork.groupsites.com/files/1035830	According to the AR template for 2021, this field is no longer required	<ul style="list-style-type: none"> •Geographic Scope: Multi-national. •Countries: China, Indonesia, Sri Lanka, Myanmar, Thailand, The Socialist Republic of Viet Nam.
	(Rice) Contract farming in Benin increased productivity by 473 kg per hectare or about 29 percent higher yields than the control. Aminou Arouna, Jeffrey D.Michler, Jourdain C. Lokossou, 2021. Contract farming and rural transformation: Evidence from a field experiment in Benin. Journal of Development Economics, Volume 151, June 2021, 102626. https://doi.org/10.1016/j.jdeveco.2021.102626	According to the AR template for 2021, this field is no longer required	<ul style="list-style-type: none"> •Geographic Scope: National. •Countries: Benin.
	Following the food price crisis in 2008, African governments, with support of partners including AfricaRice, JICA, etc., implemented policies through the Coalition for African Rice Development (CARD) aiming at double rice production by 2018. The CARD policy contributed to increase rice production in 2018 by 10.2 million ton. This resulted from the increasing of area and yield by 23% and 19%, respectively. Aminou Aroun, Irene Akoko Fatognon, Kazuki Saito, Koichi Futakuchi, 2021. Moving toward rice self-sufficiency in sub-Saharan Africa by 2030: Lessons learned from 10 years of the Coalition for African Rice Development. World Development Perspectives, Volume 21, March 2021, 100291.	According to the AR template for 2021, this field is no longer required	<ul style="list-style-type: none"> •Geographic Scope: Regional. •Regions: Africa. •Countries: Benin.
	In Colombia, in 2013, the Alliance of Bioversity-CIAT and Fedearroz, Fenalce, and the Ministry of Agricultural and Rural Development initiated technical and scientific cooperation to increase the federations' capacity to identify potential agricultural threats from climate change and to develop management options. In 2020, digital agriculture tools have reached 24% of rice and maize producers (around 4,000 ha), increasing 2020 yields by 26% on average (41% maize, 12% rice). Andrade, R., Ibarra, L., Ortega, J. (2021). Too Little, too late? Rice production to mitigate climate change in Colombia. Colombia. Alliance Bioversity-CIAT. Cali, Colombia (mimeo) Gallego, J., Wiesner, D., Jerez, K., Betancourth, A., Ortega, J., Bateman, A., González, C., Andrade, R., Ibarra, L., Álvarez, A., Cubillos, N. (2021). Evaluación de Impacto Informe final: resultados y recomendaciones. INSUCO. CIAT. GCF	According to the AR template for 2021, this field is no longer required	<ul style="list-style-type: none"> •Geographic Scope: National. •Regions: Africa. •Countries: Colombia.
2.2 MINIMUM DIETARY REQUIREMENTS: 30 million	The adoption of submergence-tolerant rice varieties in northern Bangladesh increased home rice consumption by 15%. Bairagi et al. (2021). Flood-tolerant rice improves climate resilience, profitability, and household	According to the AR template for	<ul style="list-style-type: none"> •Geographic Scope: National. •Countries:

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more people, of which 50% are women, meeting minimum dietary energy requirements	consumption in Bangladesh. Food Policy xxxx; https://www.journals.elsevier.com/food-policy	2021, this field is no longer required	Bangladesh.
2.3 MICRONUTRIENT DEFICIENCIES: 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	In Bangladesh, high-zinc rice varieties have been developed and released to address the problem of zinc deficiency, particularly among children and pregnant women. The adoption of high-zinc rice in Aman season declined from 59% in 2018 to 7.5% in 2020 among treated farmers and from 12.9% to 1.9% among control farmers. Nutrition training has a long-term but diminishing impact on the adoption of high-zinc rice. Among treatment farmers, unavailability of seeds and low yields were cited as major reasons for not using high-zinc rice, while lack of knowledge about high-zinc rice was a dominant reason among control farmers. Valera et al. 2021: Impact of Nutrition Training on Long-Term Adoption of High Zinc Rice: A Randomized Control Trial Study Among Female Farmers in Bangladesh. Valera et al. 2021: Impact of Nutrition Training on Long-Term Adoption of High Zinc Rice: A Randomized Control Trial Study Among Female Farmers in Bangladesh	According to the AR template for 2021, this field is no longer required	•Geographic Scope: National. •Countries: Bangladesh.
2.4 WOMEN'S NUTRITION: 10% reduction in women of reproductive age who are consuming less than the adequate number of food groups	No new contribution in 2021	According to the AR template for 2021, this field is no longer required	•Geographic Scope: Global.
3.1 WATER AND NUTRIENT EFFICIENCY: 5% increase in water and nutrient (inorganic, biological) use efficiency in agro-ecosystems, including through recycling and reuse	A meta-analysis compared Site Specific Nutrient Management (SSNM) with farmers' fertilizer practice for maize, rice and wheat using 61 published papers across 11 countries. Relative to the farmer practice, across the crops maize, rice and wheat, SSNM resulted in 10% less fertilizer nitrogen applied, thereby improving nitrogen use efficiency and reducing nitrogen pollution to the environment. Pauline Chivenge, Kazuki Saito, Michelle Anne Bunquin, Sheetal Sharma and Achim Dobermann (2021). "Co-benefits of nutrient management tailored to smallholder agriculture" Global Food Security 30 (2021) 100570. https://www.sciencedirect.com/science/article/pii/S221191242100078X	According to the AR template for 2021, this field is no longer required	•Geographic Scope: Multi-national. •Countries: Bangladesh, Burkina Faso, China, Ghana, Indonesia, India, Nepal, Philippines, Senegal, Thailand, The Socialist Republic of Viet Nam.
3.2 REDUCED GREENHOUSE GAS EMISSION: Reduce agriculturally-related	No new contribution in 2021	According to the AR template for 2021, this field is	•Geographic Scope: Global.

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greenhouse gas emissions by 0.2 Gt CO ₂ -e yr ⁻¹ (5%) compared with business-as-usual scenario in 2022		no longer required	
3.3 ECOSYSTEM RESTORED: 55 million hectares (ha) degraded land area restored	N/A		
3.4 PREVENTION OF DEFORESTATION: 2.5 million ha of forest saved from deforestation	N/A		

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	
628 - Policy tool for sustainable rice value chain development in Ghana	AfricaRice and FAO developed a prospective analysis of rice value chain development with account for environmental impact. The net present value for the growth scenario is USD378 million after investment.	Stage 1	<ul style="list-style-type: none"> • Conducive agricultural policy environment • Enhanced adaptive capacity to climate risks (More sustainably managed agro-ecosystems) 	1 - Significant	1 - Significant	1 - Significant	2 - Principal	The world is facing two interconnected crises: the climate change and the COVID-19 pandemic. To build back better from the COVID-19 pandemic in the context of climate change, prospective analyses were conducted to identify strategies for sustainable and pro-poor growth of the rice-based food system. In Ghana, through the implementation of the best practices, along with the expansion of rice growing areas, the gross production value of the rice value chain would reach USD 856 million, which is an additional USD 511 million in gross production value by 2030. An upgraded rice value chain would also result in an increase in the value added by USD 378 million by 2030. The rice value chain would also experience an increase in employment with more than 60 000 additional jobs created by 2030, with 12 000 jobs

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								opportunities for women and 30 000 for the youth. In terms of the upgraded value chain's environmental impact, rice would create an overall positive carbon balance and emit 284 852 tCO ₂ -e in greenhouse gas emissions. The global economic and environmental benefits result in a net present value for the growth scenario of USD 397 million after investment.
629 - Policy tool for sustainable rice value chain development and environmental impact in Cote d'Ivoire	AfricaRice and FAO developed a prospective analysis of rice value chain development with account for environmental impact. The net present value for the growth scenario is USD604 million after investment.	Stage 1	<ul style="list-style-type: none"> • Reduced net greenhouse gas emissions from agriculture, forests and other forms of land-use (More sustainably managed agro-ecosystems) • Enhanced adaptive capacity to climate risks (More sustainably managed agro-ecosystems) 	1 - Significant	1 - Significant	1 - Significant	2 - Principal	To build back better from the COVID-19 pandemic in the context of climate change, prospective analyses were conducted to identify strategies for sustainable and pro-poor growth of the rice-based food system. In Cote d'Ivoire, the scenario should make it possible to increase production from 2.05 million tonnes to 4.28 million tonnes between 2020 and 2030. The use of the EX-ACT VC tool has made it possible to estimate the total added value of the sector which is currently valued at USD 436 million. Under the growth scenario, this added value is expected to increase to USD 1.04 billion. This should translate into an improvement in the income of the actors. The analysis also indicates that the self-sufficiency scenario is expected to result in the creation of 234. 000 additional jobs in the sector over the next ten years, mainly in production and processing. In the growth scenario, the sector will be able to reduce its emissions by 1.28 million tCO ₂ -e. Considering the economic value of a ton of tCO ₂ -e sequestered at 30 USD, this environmental performance is evaluated at 38 million USD per year.

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<p>630 - Policy tool for sustainable rice value chain development and environmental impact in Mali</p>	<p>AfricaRice and FAO developed a prospective analysis of rice value chain development with account for environmental impact. The net present value for the growth scenario is USD602 million after investment</p>	<p>Stage 1</p>	<ul style="list-style-type: none"> • Reduced net greenhouse gas emissions from agriculture, forests and other forms of land-use (More sustainably managed agro-ecosystems) • Increased capacity for innovations in partner research organization 	<p>1 - Significant</p>	<p>1 - Significant</p>	<p>1 - Significant</p>	<p>2 - Principal</p>	<p>The world is facing two interconnected crises: the climate change and the COVID-19 pandemic. Prospective analyses were conducted to identify strategies for sustainable and pro-poor growth of the rice-based food system. The results indicate that Mali can be self-sufficient and a net exporter of rice by 2030 if production grows at a rate of at least 6.6 percent per year for 10 years and from 2.8 to 5.5 million tons. The strategies proposed to achieve this will create an additional added value of \$ 602 million over 10 years, or an average annual growth of 7.15 percent in the sector. The development of the sector will also generate the creation of nearly 240,000 jobs. In terms of environmental impact, adopting good agricultural practices will sequester a significant amount of carbon. Greenhouse Gas (GHG) emissions will drop from 7 million to 4.8 million tCO₂-e, or nearly 2.2 million tCO₂-e sequestered. The assessment of the carbon footprint shows that emissions decrease from 6.4 to 4.1 tCO₂-e per ton of rice obtained or from 4.30 to 1.77 tCO₂-e per hectare of rice cultivation. The monetary value of this environmental gain is estimated at US\$ 66.4 million, or US\$ 66.5 per hectare per year.</p>
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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
OICR3215 - Participation of rice farmers to contract farming increased their income by \$140 per capita in Benin	Link	Stage 3
OICR3893 - CARD initiative has contributed to increase rice production by 10.2 million ton in 2018	Link	Stage 3
OICR4231 - Co-benefits of site-specific nutrient management for maize, rice, and wheat tailored to smallholder agriculture	Link	Stage 3
OICR4233 - Adoption of the improved rice management package '1 Must Do-5 Reductions' (1M5R) in Vietnam	Link	Stage 3
OICR4236 - Impact of Nutrition Training on Long-Term Adoption of High-Zinc Rice: A Randomized Control Trial Study among Female Farmers in Bangladesh	Link	Stage 1
OICR4241 - Adoption of stress-tolerant rice varieties and their economic impact in flood-risk areas in India	Link	Stage 2
OICR4254 - Flood-tolerant rice improves climate resilience, profitability, and household consumption in Bangladesh	Link	Stage 3

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OICR4259 - Over 780,000 farm households in South-East and East Asia adopt improved rice management practices	Link	Stage 3
OICR4265 - Sahel 108 allowing double cropping under climate change effect occupied more than 70% of of the total rice area in both the wet and dry seasons in Senegal	Link	Stage 3
OICR4267 - Adoption of an improved variety (MAC18) that has reached 25% Bolivian rice farmers , contributing to adopting other technologies and increasing productivity and market access	Link	Stage 3
OICR4268 - The adoption of improved varieties (SFL-09 and SFL-11) has contributed to lower costs for almost 6 out of 10 rice farmers in Ecuador between 2014 and 2019.	Link	Stage 3
OICR4269 - Digital agriculture tools have reached 24% of rice and maize producers (around 4,000 ha), increasing 2020 yields by 26% on average (41% maize, 12% rice) in Colombia	Link	Stage 3
OICR4370 - Helping Feed the World with Rice Innovations: RICE Research Adoption and Impact on Farmers Globally	Link	Stage 2

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)
533 - Development of Solar Bubble Dryer Mark II for rice	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Global
534 - GrainSafe Dryer and hermetic rice storage system	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional: South-Eastern Asia, Southern Asia, Western Africa
596 - RiceAdvice: an android based decision support tools for Nigeria	Production systems and Management practices	Stage 4: uptake by next user (USE)	National
602 - Alternate wetting and drying (AWD) in Asia	Production systems and Management practices	Stage 4: uptake by next user (USE)	Multi-national
652 - '1 Must 5 Reductions (1M5R)' integrated rice management package	Production systems and Management practices	Stage 4: uptake by next user (USE)	National
654 - MINCER micrometeorological station used to improve spikelet sterility estimations in crop models for rice	Biophysical Research	Stage 3: available/ ready for uptake (AV)	Global
657 - Hoja blanca disease screening system	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	Multi-national
676 - Improved rice lines with high Zinc	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC)	Global, Regional: Latin

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concentrations		- end of research phase)	America and the Caribbean
810 - AfricaRice weather: a free web-database	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Regional: Sub-Saharan Africa
811 - Development of improved wet-milled rice flour product (Rice flakes)	Other	Stage 3: available/ ready for uptake (AV)	Regional: South-Eastern Asia
813 - Lab-scale pop-rice equipment is upscaled and simplified for dissemination in West Africa.	Other	Stage 3: available/ ready for uptake (AV)	Regional: Western 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
819 - Rice Crop Manager - Odisha	Production systems and Management practices	Stage 4: uptake by next user (USE)	Sub-national
820 - Rice Crop Manager - Philippines	Production systems and Management practices	Stage 4: uptake by next user (USE)	National
830 - GEM and Mini GEM: two novel parboiling technologies for West-Africa	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Regional: Western Africa
842 - Low glycemic rice product	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Global
844 - Two blast-resistant elite rice lines with Pi9 introgressed	Genetic (varieties and breeds)	Stage 4: uptake by next user (USE)	National: Global, Colombia
867 - Rice straw processing for ruminant feeding	Production systems and Management	Stage 4: uptake by next user (USE)	Multi-national

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supplement	practices		
870 - CIAT BIO-44, a new rice line with 25 ppm Zinc considered for release by Bolivia	Genetic (varieties and breeds)	Stage 4: uptake by next user (USE)	National: Bolivia
871 - Indicators and protocol to identify sustainable post harvest management practices in rice production in Vietnam and Myanmar	Production systems and Management practices	Stage 4: uptake by next user (USE)	Multi-national: Lao People's Democratic Republic
886 - Multipurpose grinder	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Regional: Western Africa
887 - Multi-Piston briquetting technology	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Regional: Western Africa
1018 - Sustainable Rice Platform (SRP) Standard and Performance Indicators in Africa	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Regional: Sub-Saharan Africa
1020 - Upland rice-based cropping systems with conservation agriculture in Ivory Coast	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National
1021 - RiceAdvice-WeedManager android application for Sub-Saharan Africa	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	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
1039 - Good Agricultural Practices (GAP) for improving rice productivity in Senegal	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National

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1049 - Mechanical seeders to save labor for direct seeded rice in the lowland and upland of Madagascar	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National
1050 - Fertiseeder, a manual seeder cum fertilizer micro-dose applicator in Madagascar	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National
1051 - Two-row 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 in Eastern Africa	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	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) to improve rice productivity in Tanzania	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National
1056 - Good agricultural practices (GAP) to improve rice productivity in Madagascar	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National
1057 - Good agricultural practices (GAP) to improve rice productivity in Uganda	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National
1058 - Development of micronutrient fertilizer strategies for rice yield increase in Sub-Saharan	Production systems and Management practices	Stage 1: discovery/proof of concept (PC)	Regional: Sub-Saharan Africa

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Africa	practices	- end of research phase)	
1125 - A new protocol for rice postharvest loss valuation in Sub Saharan Africa and strategies for loss reduction	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Regional: Sub-Saharan Africa
1133 - Method for Screening low glycemic rice in the germplasm	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Global
1237 - Best-fit contract farming models in Benin	Social Science	Stage 4: uptake by next user (USE)	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
1412 - National policy for restructuring the Vietnamese rice sector: Towards 2020 and Vision to 2030	Production systems and Management practices	Stage 4: uptake by next user (USE)	National
1413 - Access of youth agripreneurs to agricultural finance for entrepreneurship and self-employment	Social Science	Stage 3: available/ ready for uptake (AV)	Multi-national
1756 - Good Agricultural Practices (GAP) to improve crop productivity in Rwanda	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National
1785 - Biofortified rice variety Fedearroz BioZN-035 for Colombia	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	Regional: Latin America and the Caribbean
1807 - ASI thresher for reducing postharvest loss in rice production in Sub-Saharan Africa	Production systems and Management practices	Stage 4: uptake by next user (USE)	Regional: Sub-Saharan Africa

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1895 - blast pathogen characterization in Colombia	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	National
1928 - NOISYmputer v0.5, an updated algorithm for imputation of low-depth sequencing data in bi-parental populations of diploid species	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Global
1953 - OneRice breeding strategy	Research and Communication Methodologies and Tools	Stage 4: uptake by next user (USE)	Global
1960 - Reinventing Rice Breeding: One pipeline: Two systems	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Global
2348 - Dry-seeded rice (DSR) breeding lines	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
2349 - Low glycemic index rice variety NSIC RC182	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	Global
2350 - Rice variety (NSIC RC278) with intermediate glycemic index	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	Global
2351 - Rice variety (NSIC RC 280) with intermediate glycemic index	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	Global
2353 - New rice variety F191 for the uplands in Madagascar	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	Sub-national: Madagascar
2355 - Genomic Selection models for the 3K SNP-Seek set for 1) grain Zn concentrations and 2) yield under low-fertility conditions in Madagascar.	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National: Madagascar

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2356 - Rice variety donors for tolerance to Fe toxicity in West-Africa among interspecific O sativa x O. glaberrima lines of a QTL mapping population	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional: Western Africa
2357 - IR64 NILs for partial blast resistance genes; pi21(BC5F5), Pi35(BC2F5), and Pb1(BC6F5).	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
2358 - NILs in the genetic background of IR 64 and Sahel108 having introgressed the actpk1 gene that increases ammonia uptake.	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
2359 - 2 potential upland rice varieties with 15 - 20% reduction in yield loss caused by low soil fertility in Madagascar	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National: Madagascar
2360 - Toolkit Smart-Valleys	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Regional: Multi-national: Burkina Faso, Benin, Togo, Liberia, Western Africa
2361 - New rice variety F192 for the uplands in Madagascar	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National: Madagascar
2362 - New rice variety F193 for the uplands in Madagascar	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National: Madagascar
2363 - Germplasm for the creation of new upland rice varieties for Madagascar	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Sub-national: Madagascar
2364 - Nineteen significant marker/trait	Research and Communication	Stage 1: discovery/proof of concept (PC	Regional: Latin America and

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combinations associated with eight grain quality traits valuable for selecting rice germplasm from LAC	Methodologies and Tools	- end of research phase)	the Caribbean
2365 - Nineteen significant marker/trait combinations associated with eight grain quality traits valuable for rice breeding in LAC.	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional: Latin America and the Caribbean
2366 - Sabina FL: A new rice variety in Dominican Republic	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National: Dominican Republic
2367 - FLAR Collect: An ODK (Open Data Kit)-based free application to collect data on agronomic management and production costs of rice crops through mobile devices	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional: Latin America and the Caribbean
2368 - PyRice: a Python package for querying Oryza sativa databases	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Global
2369 - A fast annotation process with the Table2Annotation tool	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Global
2373 - Ex-ante Carbon-balance Value Chain tool (EX-ACT VC) to assess the rice value chain's environmental and socio-economic impact	Social Science	Stage 3: available/ ready for uptake (AV)	Regional: Sub-Saharan Africa
2374 - Twelve high yielding and nutritious lines of irrigated lowland rice breeding lines identified	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Sub-national: Multi-national: Regional: Senegal, Guinea, Burkina Faso, Mali, Nigeria, Côte d'Ivoire, Africa

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2378 - Direct seeded rice (DSR) field facilities at IRRI HQ, IRRI South Asia Hub, IRRI ESA (Kenya), AfricaRice (Senegal, Ivory Coast)	Other	Stage 3: available/ ready for uptake (AV)	Multi-national: Senegal, India, Philippines, Côte d'Ivoire, Kenya
2379 - Sahel 108: high yielding and short-duration variety	Genetic (varieties and breeds)	Stage 4: uptake by next user (USE)	National: Senegal
2380 - Breeding program organization by maturity groups as early, medium, and late maturity	Research and Communication Methodologies and Tools	Stage 4: uptake by next user (USE)	Global
2381 - Expansion of the national agriculture research and extension systems (NARES) breeding network in line with the market segmentation	Research and Communication Methodologies and Tools	Stage 4: uptake by next user (USE)	Global
2385 - Genetic markers for disease monitoring	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
2386 - Adoption of a the digital decision support tool Rice Crop Manager (RCM) by the government of the Philippines	Production systems and Management practices	Stage 4: uptake by next user (USE)	National: Philippines
2387 - Scaling of use of Automon for improved water management and a reduction in green house gas emissions in Indonesia	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National: Indonesia
2388 - Adoption of direct-seeded rice (DSR) as a result of labor shortages in the Indo-Gangetic plains due to restrictions on migrant labor	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National: India

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2390 - Twelve irrigated lowland rice breeding lines possessing resistance genes for RYMV, bacterial blight and blast identified	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global, Regional: Africa
2391 - Unified rice breeding strategy for AfricaRice and IRRI developed	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	Global, Regional: Asia, Africa
2392 - Knowledge of population structure of species causing Brown spot disease of rice in Burkina Faso	Research and Communication Methodologies and Tools	Stage 4: uptake by next user (USE)	National: Burkina Faso
2393 - Eleven new hybrids out-yielding best local check by 11-25% identified in Cote d'Ivoire	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National: Côte d'Ivoire
2394 - New irrigated lowland rice variety FOFIFA 187 released in Madagascar	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National: Madagascar
2395 - One new rice variety FOFIFA 188 released in Madagascar for irrigated systems	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National: Madagascar
2396 - CRAM 1 (ARICA 14), a high yielding rice variety, released in Cote d'Ivoire	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	Regional: National: Côte d'Ivoire, Sub-Saharan Africa
2397 - High yielding variety, FOFIFA 189, released for irrigated lowland systems in Madagascar	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National: Madagascar
2398 - FOFIFA 190, high yielding irrigated lowland variety, released for irrigated lowlands in Madagascar	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National: Madagascar

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2401 - High yielding Rainfed upland rice variety, CRAM 2 (ARICA 15) released for upland production systems in Cote d'Ivoire	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	Regional: National: Côte d'Ivoire, Sub-Saharan Africa
2402 - A high yielding rice variety, CRAM 3 (ARCC3Fa3L10P1-1-B-1) was released in Cote d'Ivoire for rainfed upland systems	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National: Regional: Côte d'Ivoire, Sub-Saharan Africa
2403 - Early, maturing and high yielding Rainfed upland rice variety, CRAM 4 (ART15-16-12-3-1-B-1-B-3-1), released in Cote d'Ivoire	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National: Regional: Côte d'Ivoire, Sub-Saharan Africa
2405 - Twenty elite upland rice breeding lines exceeding NERICA 4 in yield by more than 20% identified in Cote d'Ivoire	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	National: Côte d'Ivoire
2406 - A mini-core collection of 350 O. glaberrima accessions identified capturing more than 98% genetic variation	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global, Regional: Sub-Saharan Africa
2407 - MAC 18	Genetic (varieties and breeds)	Stage 4: uptake by next user (USE)	National: Bolivia
2408 - 130 germplasm from 9 NARS partners fingerprinted for 43 QTLs/genes	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global, Regional: Asia, Sub-Saharan Africa
2409 - SFL 09 y SFL 11	Genetic (varieties and breeds)	Stage 4: uptake by next user (USE)	National: Ecuador
2410 - Digital agriculture workshops	Production systems and Management practices	Stage 4: uptake by next user (USE)	National: Colombia

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2411 - EasyHarvest: a digital tool for smart management of agricultural machinery and paddy and residue logistics in Philippines and Vietnam	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Multi-national: The Socialist Republic of Viet Nam, Philippines
2412 - Mechanized composting for converting crop residues into organic fertilizer in Vietnam	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National: The Socialist Republic of Viet Nam
2413 - Bio-diversified upland rice based cropping systems in Madagascar	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National: Madagascar
2414 - Drone based phenotyping for rice	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Global
2415 - Rice ImageBreed	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
2421 - A new high-yield red rice variety for rainfed ecology (FOFIFA 191) in Madagascar	Genetic (varieties and breeds)	Stage 4: uptake by next user (USE)	National: Madagascar
2422 - A new high-yield red rice for rainfed lowland ecology (FOFIFA 193) in Madagascar	Genetic (varieties and breeds)	Stage 4: uptake by next user (USE)	National: Madagascar
2424 - A new high-yield rice for rainfed ecology (FOFIFA 194) in Madagascar	Genetic (varieties and breeds)	Stage 4: uptake by next user (USE)	National: Madagascar
2425 - Characterization of Reference panel for grain quality and nutritional traits	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
2426 - Promising donor germplasm and breeding lines	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	Multi-national: The Socialist Republic of Viet Nam, India, Bangladesh, Philippines,

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			Burundi
2429 - Smart-Valleys approach for enhancing rice yield and reducing yield gap in West Africa	Production systems and Management practices	Stage 4: uptake by next user (USE)	Regional: Western Africa
2430 - Smart-Valleys approach in Ivory Coast	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	National: Côte d'Ivoire
2431 - Production of vegetables and legumes in the off-season in rotation to rainfed rice in inland valleys under optimal irrigation scheduling.	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	National: Côte d'Ivoire
2432 - Novel market segmentation based on cultural heritage in West Africa	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional: Sub-Saharan Africa
2435 - Determinants of adoption of accelerated rice breeding	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
2440 - Evidence of spillover effect of direct competition between marketing cooperatives and private intermediaries in Thai rice value chains	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	National: Thailand
2441 - Novel evidence on inclusiveness of consumer access to packaged and certified rice in South and Southeast Asia	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional: South-Eastern Asia, Southern Asia
2442 - Novel toolkit of gastronomic systems research (GSR) for unraveling drivers of food choice	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	National: India

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2443 - Novel value chain upgrading strategy for valorization of heirloom rice in Philippines	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	National: Philippines
2444 - Novel market segmentation approach for rice farmers in Philippines	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	National: Philippines
2445 - Novel evidence on the determinants of the global burden of hunger	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
2456 - Two main biological/genomic resources for additional contribution to harnessing genetic diversity	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global

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

FP	FP Outcomes 2022	Sub-DOs	Summary narrative on progress against each FP outcome this year.	Milestone	2021 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	<ul style="list-style-type: none"> Increased capacity for innovations in partner research organizations 	The IRRI Global Rice Model has been upgraded and can be integrated into other cereal-based models for global simulations. IRRI and AfricaRice actively contributed to the activities of the CGIAR Foresight Team, including the development of the CGIAR Foresight Report, and the Future of X. IRRI and AfricaRice demonstrated their capabilities to proactively engage in national policies. For instance, IRRI foresight was often referenced in the policy discussion of the Rice Tarrification Law in the Philippines. On-going foresight work of AfricaRice will be used to develop 'Continental Investment Plan for accelerating Rice Self-Sufficiency in Africa' (CIPRISSA) for Benin.	2021 - Updated rice supply-demand scenario analyses used as inputs into the 2022-2024 business plan	Completed	The IRRI Global Rice Model (IGRM) has been upgraded and can be easily integrated into other existing cereal-based models for global simulations. IRRI and AfricaRice have 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 to examine the future trend of rice-based systems to guide the agri-food transformation. IRRI and AfricaRice demonstrated their capabilities to proactively engage in national policies. Self-sufficiency in rice production is a strong target of Sub-Sharan African countries. To account for sustainable and effect of on environment while pursuing this objective, the ex-ante impact of rice value chain development is currently on-going. The first application will be in Cote d'Ivoire, Mali and Ghana. Results from on-going foresight work will be used to develop 'Continental Investment Plan for accelerating Rice Self-Sufficiency in Africa' (CIPRISSA) for Benin.	<ul style="list-style-type: none"> https://grispnetwork.org/post/over-5000-rice-
	F1 Outcome: Improved role in	<ul style="list-style-type: none"> Optimized consumption of 	Access to access to inputs was facilitated by providing starter kits to subsistence	2021 - Evaluation of the changes in	Completed	In Africa, the COVID-19 pandemic is already disrupting millions of people's livelihoods, with a disproportionate	<ul style="list-style-type: none"> https://www.africarice.org/post/over-5000-rice-

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	decision making by women and youth in rice value chains as evidenced by empowerment measures at key action sites	diverse nutrient-rich foods	farmers having 1 ha or less among mainly women and youth groups. A total of 1000 starter kits is distributed with 500 kits of seed, fertilizer, and 500 kits of seed, fertilizer, and irrigation cost. Gender-disaggregated data of socioeconomic surveys of farm households on technology needs, technology performance in farmers fields, and adoption constraints were analyzed. Findings are presented in reports and peer-reviewed journals	women's and youth's role in decision making conducted, and feedback provided to project leaders, national partners and donors.		impact on poor households and small and informal businesses. While many initiatives are underway to avert the health crisis, the economic crisis needs equal attention to prevent an exacerbated human and social disaster caused by the disruption of food supply and unemployment. The objective of the initiative is to promote and develop entrepreneurship in the rice value chain in Senegal to enhance the resilience of the country during and after the COVID-19 crisis. 1000 kits were distributed to 1000 farmers among which 70% are women. In this initiative AfricaRice works in partnership with Mastercard Foundation, Ministry of Agriculture and Rural Equipment of Senegal, Syngenta Foundation for Sustainable Agriculture, National Agriculture Bank (LBA).	value-chain-actors-in-senegal-to-benefit-from-youth-focused-covid-19-response
	F1 Outcome: Collective innovation and seed systems	<ul style="list-style-type: none"> Increased capacity for innovation in partner development organizations and in poor and vulnerable communities 	IRRI creatively engaged with stakeholders in Bihar, Odisha and Assam. New initiatives for engagement also started with Maharashtra and UP. IRRI responded proactively to the request from the government of Assam and prepared a rice strategy for the state. This strategy highlights the importance of seed system upgrading, mechanization, development of service economy, value chain engagement, and premium/traditional rice processing and marketing programs. Also a scaling strategy to create awareness using community video screening was developed and handed over to the Odisha government. In Benin, participation in collective marketing increased the income of rice farmers by USD 148/ha on average.	2021 - 100% of key regions have at least one functional multistakeholder platform at key action sites	Completed	Market access is a major constraint of smallholder rice producers in sub-Saharan Africa (SSA). There is increasing evidence that acting collectively offers one way for smallholders to participate more efficiently in the market. This study aimed to identify the determinants of participation in collective marketing of rice in innovation platforms in Benin and quantify its impact on household income and food security. The study used the local average treatment effect parameter to assess the impact of collective marketing of rice. Data were collected from a random sample of 257 smallholder rice producers. Results showed that participation in collective marketing increased the income of rice farmers on average by USD 148/ha. Main determinants of participation in collective marketing of rice were membership in a farmer group, training, and agreement on price. This study concludes that better training and well-functioning farmer groups sustain the impact of collective marketing of rice on food security.	<ul style="list-style-type: none"> https://www.intechopen.com/chapters/60507
	F1 Outcome:	<ul style="list-style-type: none"> Enhanced 	Based on two studies on the Rice	2021 - At least 2		AfricaRice and FAO developed a prospective analysis of	<ul style="list-style-type: none"> https://doi.org/10.4060/

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<p>Effective networks and mechanisms to provide policy makers with up-to-date and evidence-based information on the rice sector</p>	<p>individual capacity in partner research organizations through training and exchange</p> <ul style="list-style-type: none"> • Increase capacity of beneficiaries to adopt research outputs 	<p>Tarification Law published in 2020, the IRRI 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. Prospective analysis and strategies for sustainable and pro-poor growth of rice value chain in West Africa were conducted. Resilient models were proposed for rice value chain development taking into account both economic and environmental impact in West Africa Build back better from the COVID-19 pandemic in the context of climate change</p>	<p>agrifood policies informed by recommendation from rice science are adopted in Asia, Africa and Latin America and Caribbean</p>	<p>Completed</p>	<p>rice value chain development. In Ghana, through the implementation of these practices, the gross production value of the rice value chain would reach USD 856 million, which is an additional USD 511 million in gross production value by 2030. The rice value chain would also experience an increase in employment with more than 60 000 additional jobs created by 2030, with 12 000 jobs opportunities for women and 30 000 for the youth. In Cote d'Ivoire, the scenario should make it possible to increase production from 2.05 million tons to 4.28 million tons between 2020 and 2030. In the growth scenario, the sector will be able to reduce its emissions by 1.28 million tCO₂-e. Mali can be self-sufficient and a net exporter of rice by 2030 if production grows at a rate of at least 6.6 percent per year for 10 years and from 2.8 to 5.5 million tons. The strategies proposed to achieve this will create an additional added value of USD 602 million over 10 years, or an average annual growth of 7.15 percent in the sector. Cambodia launched a registry for companies that allows to import biological control agents.</p>	<p>cb1506fr•https://www.fao.org/documents/card/en/c/cb1504fr•https://www.fao.org/documents/card/en/c/cb1659en•https://www.khmertimeskh.com/60664/use-less-chemicals-farmers-told/•https://agrilinks.org/post/cambodian-farmer-between-2020-and-2030-the-implements-and-modifies-machinery-improves-quality-rice•https://vtx.vt.edu/articles/2020/01/outreach-t.html?utm_source=cmpg_n_news&utm_medium=email&utm_campaign=vtUnirelNewsDailyCMP_021120-f%2Fs•https://www.khmertimeskh.com/97360/biological-pest-control-agents-given-green-light-government/</p>
<p>F1 Outcome: Impacts and adoption of RICE technologies assessed and published</p>	<ul style="list-style-type: none"> • Increase capacity of beneficiaries to adopt research outputs 	<p>Several Ex-post impact assessment studies were conducted in 2021:- Assessing the benefits of Green Super Rice in sub-Saharan Africa- Assessing International Rice Genebank's germplasm dissemination pathways and impact on improved rice varieties in Bangladesh- Information quality, adoption of climate-smart varieties and their economic impact in flood-risk areas- Caste, Social Networks and Variety Adoption- Impact of COVID-19</p>	<p>2021 - Cross-regional analysis and comparison of impact of adoption of RICE-developed technologies to date</p>	<p>Completed</p>	<p>A synthesis review has been conducted to examine the cross-regional analysis and comparison of impact of adoption of RICE-developed technologies to date. The article reviews 20 ex-post impact assessment studies on rice varieties, agronomic practices, institutional arrangements, information and communication technologies, and post-harvest technologies used by rice farmers in the developing world from 2016 to 2021 of the CGIAR RICE agri-food program implementation. We found that stress-tolerant varieties in Asia and New Rice for Africa (NERICA) varieties in Africa had a significant impact</p>	<p>•https://grisnetwork.org/upsite.com/</p>

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			on food consumption, job loss, and income- Data were collected on households in Senegal to assess the impact of RiceAdvice. - Data were collected on households to assess the impact of ARICA varieties in Benin, Madagascar and Nigeria.			on rice yield and income. Additionally, institutional innovations, training, and natural resource management practices, such as direct-seeded rice, rodent control, and iron-toxicity removal, have a considerable effect on smallholder rice farmers' economic well-being (income and rice yield). Given the important uptake of stress-tolerant varieties documented in Latin America, additional positive impacts are expected.	
	F1 Outcome: Functional and effective results-based management system for RICE and its partners	<ul style="list-style-type: none"> Increased capacity for innovations in partner research organizations 	The MARLO platform was used for monitoring, evaluation and learning of the RICE outcomes, the tracking of milestones and the reporting of outcomes. Because of the COVID pandemic the annual MELIA workshop could not be organized.	2021 - Reflective learnings of RICE to date synthesized and used as inputs in the 2022-2024 business plan	Completed	- A synthesis review has been conducted to examine the cross-regional analysis and comparison of impact of adoption of RICE-developed technologies to date. The article reviews 20 ex-post impact assessment studies on rice varieties, agronomic practices, institutional arrangements, information and communication technologies, and post-harvest technologies used by rice farmers in the developing world from 2016 to 2021 of the CGIAR RICE agri-food program implementation. - A meta-analysis comparing SSNM with farmers' fertilizer practice for maize, rice and wheat was performed on 61 published papers across 11 countries. Relative to the farmer practice, across all crops SSNM increased grain yield by 12% and profitability by 15% with 10% less fertilizer nitrogen applied, thereby improving nitrogen use efficiency and reducing nitrogen pollution to the environment. - A recent article traces the technological development and uptake of 1M5R in national policies and by end-users. The article highlights the outcomes from various policy-supported initiatives and unpack plausible pathways that generated the widespread adoption of 1M5R in eight provinces in the Mekong River Delta	<ul style="list-style-type: none"> https://www.sciencedirect.com/science/article/pii/S221191242100078X https://www.mdpi.com/2073-4395/11/9/1707
F2	F2 Outcome: Diversified enterprise opportunities through upgraded	<ul style="list-style-type: none"> Diversified enterprise opportunities 	GEM and Mini GEM parboilers were piloted in Benin, Cote d'Ivoire, Niger, Nigeria and Togo. The technology improves grain quality, reduces energy	2021 - Value chains upgraded at three action sites upgrading strategy	Completed	New technologies that diversify enterprise opportunities were developed and piloted in more than six action sites. Novel market intelligence was generated, published and submitted as innovations or highlights that enables	<ul style="list-style-type: none"> https://tinyurl.com/yfxyg8p9 https://grispnetwork.k.groupsie.com/files/1035694 https://tinyurl.com

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<p>value chains at six action sites (Indonesia, Myanmar, Vietnam; Cote d'Ivoire, Nigeria, Tanzania)</p>		<p>use and drudgery at the benefit of women who dominate the parboiling industry, and enables using rice husk, an underutilized biomass as parboiling fuel in place of wood. A multipurpose grinder for cereals, rice husk and other dry agricultural residues was fabricated, tested, validated, and piloted in Benin and Cote d'Ivoire. A Multi-Piston briquetter targeting young small-scale processors of agricultural waste such as rice husk has been fabricated, tested and validated in Cameroon, Benin and Cote d'Ivoire.</p>	<p>expanded with lessons captured in three additional action sites</p>		<p>breeders, value chain actors and policy makers develop and target new varieties, products, technologies and policies to well-defined farmer and consumer market segments: 1. Novel market segmentation based on cultural heritage in West Africa (Innovation 2432) 2. Hedonic pricing of rice attributes, market sorting, and gains from quality improvement in the Beninese market (Highlight 1117) 3. Novel value chain upgrading strategy for valorization of heirloom rice in Philippines (Innovation 2443) 4. Novel evidence on inclusiveness of consumer access to packaged and certified rice in South and Southeast Asia (Innovation 2441) 5. Novel market segmentation approach for rice farmers in Philippines (Innovation 2444) 6. Evidence of spillover effect of direct competition between marketing cooperatives and private intermediaries in Thai rice value chains (Innovation 2440) 7. Novel evidence on the determinants of the global burden of hunger (Innovation 2445) 8. Determinants of adoption of accelerated rice breeding (Innovation 2435) 9. Review paper on the role of cultural heritage in global food security 10. Impact of the improved parboiler on women consumers</p>	<p>/yfxyg8p9•https://doi.org/10.1017/age.2020.24•https://doi.org/10.1093/qopen/qaob014•https://doi.org/10.1177/00307270211019758•https://grispsnetwork.groupsites.com/files/1039243•https://www.youtube.com/watch?v=2vFrC8TT0wU•https://tinyurl.com/yerwa9vf•https://grispsnetwork.groupsites.com/files/1039244</p>
<p>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)</p>	<p>• Improved access to financial and other services</p>	<p>Donor priorities shifted activities to other countries than initially planned. Ongoing innovation platforms in Nigeria, Benin, Mali and Senegal continue to successfully enhance rice value chain stakeholders' access to finance. A new study was conducted on finance options for rice farmers in Madagascar, which will help developing an ideal type of rural financing. The potential of contract farming as an alternative mechanism to overcome financial constraints of smallholder farmers was assessed in Cote d'Ivoire and evidence of adoption was documented in Vietnam. A study in</p>	<p>2021 - Income by value-chain actors increased by 10% at six action sites because of increased value chain services</p>	<p>Completed</p>	<p>The GEM parboiling system has been installed in 15 sites in eight countries (Benin (2), Cote d'Ivoire (5), Ethiopia (2), Madagascar (1), Niger (1), Nigeria (2), Senegal (1) and Togo (1) with a net gain of US\$30 per session compared to the traditional technology. EasyHarvest for smart management of agricultural machinery and paddy and residue logistics was successfully piloted for laser land leveling application in the Philippines and is being being tested for optimized wet paddy logistics of Loc Troi Group in Vietnam. EasyHarvest provides better access to harvester services, leading to an improved rice value chain, higher overall income for farmers and contractors, increased sustainability of rice production, reduction of hazardous labor and the increase in smart farming practices. In a new consumer study, we estimate a potential market size of</p>	<p>•https://www.irri.org/easylharvest•https://doi.org/10.1007/s10460-020-10159-9•https://grispsnetwork.groupsites.com/files/1039191•https://cgjar-my.sharepoint.com/:w/g/personal/s_ndindeng_cgjar_org/EfBGmUk9BBIArq9JJGNJohgB4k9g5zEHCKnPcD8QMjJ-g?e=xtn2hh&wdLOR=c32150DB7-701C-402E-9C60-894CC94254E8•https://d</p>

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			Thailand demonstrated that marketing cooperatives competitively increase paddy prices by 11%, even for non-participating farmers.			USD 443 million that could be created for heirloom rice and tapped into by smallholders in the Philippines. Finally, evidence from the Mekong Delta shows how vertical coordination (contract farming) encourages the adoption of sustainable production practices and get higher prices for their rice, as well as the secure investment from inputs and the agricultural machinery services from food companies, leading to 19–36% increases in income .	oi.org/10.3390/agronomy11091707
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	A new protocol was developed for the valuation of rice postharvest losses in Sub Saharan Africa and validate in six African countries, and strategies were developed for loss reduction. Mechanized composting for converting crop residues into organic fertilizer was developed and adopted by the private sector in Vietnam. Indicators and a protocol were developed to identify sustainable post harvest management practices in rice production in Vietnam and Myanmar and incorporated in the Sustainable Rice Standards. The adoption of sustainable production practices and impacts on income was investigated in the Mekong Delta.	2021 - Pilot users at six action sites increase income from rice by 15% through adoption of at least one of the postharvest or value addition practices or technologies	Completed	Major successes with innovation platforms centered around postharvest technologies have been documented in Africa. Market evidence from women consumers suggests improved parboiling boosts value by 9–22%. Widespread adoption of “1 Must Do and 5 Reductions” (i.e., use of certified seed and reduction of water, fertilizer, pesticide use, and post-harvest losses) in the Mekong River Delta boosts farmer incomes by 19–36%. Laser-controlled land leveling (LLL) is an important precondition to reduce agronomic inputs and postharvest losses. An assessment of sustainable performance indicators of LLL was conducted in Cambodia, the Philippines, Thailand, Vietnam, and India. Benefits include saving land use, water, and agronomic inputs, increasing yield, and decreasing postharvest losses resulting in saving energy of 3.0–6.9 GJ ha ⁻¹ and decreasing emissions by 1,151–1,486 kg CO ₂ -eq ha ⁻¹ . Additionally, LLL application can obtain a net profit of USD 52 – 84 ha ⁻¹ per rice production season in the countries studied. EasyHarvest was piloted in the Philippines and Vietnam, facilitating access to harvester services and boosting income for farmers and contractors. Finally, the CORIGAP annual report provides evidence of increases in income of 15 to 90% in six Asian countries because of increased yield and reduced input costs, partly thanks to the adoption of improved postharvest management practices.	•https://www.irri.org/eas yharvest •https://doi.org/10.3390/agronomy11091707 •https://cgia-my.sharepoint.com/:w/g/personal/s_ndindeng_cg ar_org/EfBGmUK9BBIAr 9jJGNJohgB4k9g5zEHCKn PcD8QMyl- g?e=xtn2hh&wdLOR=c32 150DB7-701C-402E-9C60- 894CC94254E8 •https://gris pnetwork.groupsites.com /files/1039193 •https://gris pnetwork.groupsites.com /files/1039191 •https://gris pnetwork.groupsites.com /files/1035830/preview •h ttps://gris pnetwork.group sites.com/files/1039192 •h ttps://gris pnetwork.group sites.com/files/1039244	

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	<p>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)</p>	<ul style="list-style-type: none"> Increased value capture by producers 	<p>Several novel rice and rice straw products were developed and made available. The effect of rice processing on human glycemic index (GI) was investigated, which enabled developing low-GI rice products. Lab-scale pop-rice equipment was upscaled and simplified for dissemination in West Africa. Improved wet-milled rice flour products (rice flakes) were developed, ready for uptake. A rice straw processing technology for producing ruminant feeding supplements was developed and taken up by NARES and disseminated to farmers in Vietnam and the Philippines. Research on cultural heritage, food choice and nutrition enables understanding how new rice products can be integrated into diets.</p>	<p>2021 - Farm-to-market strategies for improved processing and novel rice products at six action sites</p>	<p>Completed</p>	<p>Several strategies were developed for improved processing and novel rice products: - Impact of COVID-19 and integration of novel, nutritious rice products in diets in the Philippines - Communication strategy for Golden Rice in the Philippines - Market intelligence for the development of novel rice products and nutrition interventions in eastern India - Market intelligence for the development of valorization of indigenous rice in the Philippines - Marketing strategies for rice millers in Uganda - Global burden of chronic and hidden hunger for the development of nutritious rice products - Review paper on the role of cultural heritage in global food security, highlighting valorization of rice heritage products</p>	<p>•https://doi.org/10.1016/j.jgs.2021.100596•https://doi.org/10.1108/BFJ-05-2021-0505•https://doi.org/10.1007/s10460-020-10159-w•https://grisnetwork.groupsites.com/files/1035001•https://tinyurl.com/yf479g8•http://books.irri.org/Managing-rice-straw.pdf•https://doi.org/10.1016/B978-0-12-820057-5.00004-2•https://doi.org/10.1016/j.jgs.2021.100497•https://grisnetwork.groupsites.com/files/1039243•https://doi.org/10.1016/j.jgs.2020.100480</p>
<p>F3</p>	<p>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)</p>	<ul style="list-style-type: none"> Closed yield gaps through improved agronomic and animal husbandry practices 	<p>CORIGAP project disseminated best management practices to 783529 households from 2017 to 2020. Integrated crop management including mechanization options and IPM were disseminated and increased rice yield in Bangladesh, Cambodia, India, and Vietnam. In Burkina Faso, Mali, Nigeria, and Senegal, RiceAdvice generated 109,000 recommendations from 2014 to dry season in 2021. In Uganda, a total of 6480 farmers were trained on GAP of which 1037 (16%) were female farmers. In Madagascar, 43% of the 3574 rice farmers trained on GAP were women.</p>	<p>2021 - Top 10% of farmers in social groups reduce rice yield gaps by 10-15% at six action sites</p>	<p>Completed</p>	<p>1. Best management practices increased yield: Indonesia (13-90%), China (11%), Myanmar (13%), Sri Lanka (4-20%), Thailand (1%) and Vietnam (8%). 2. Scientific evidence and promotion of mechanized transplanting in Vietnam helped increase yield by 5% and reduce the risk of rice lodging at harvest and postharvest losses. 3. The healthy rice seedling increased yield by 7-10% in Bangladesh. 4. On-farm validation of WeRise in Indonesia and the Philippines showed that on average it increased rice yield by 16%. 5. Yield increase with RiceAdvice recommendations was on average 15, 16, 10, and 3%, respectively in Burkina Faso, Mali, Nigeria, and Senegal. This is equivalent to 8 to 25% yield gap reduction. There was no difference in yield increase between male and female farmers. 6. In Uganda, 100% yield increase reached with GAP. In Madagascar, yield increased with GAP from 1.5 to 3.2 t/ha in Upland and from 4.0 to 8</p>	<p>•https://doi.org/10.3390/agronomy11091707•https://onlinelibrary.wiley.com/doi/full/10.1111/ajae.12151•https://grisnetwork.groupsites.com/files/1034921•https://grisnetwork.groupsites.com/files/1035351•https://www.mdpi.com/2077-0472/11/4/346•https://content/uploads/sites/2/2021/03/New-Frontiers-in-Agricultural-Extension-Volume-II_5-1-2020_web.pdf•https://gris</p>

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						t/ha in lowland conditions. 7. The performance of the Smart-Valleys approach was assessed in 112 sites in Benin, Togo, Liberia, Sierra Leone, and Côte d'Ivoire during the wet season of 2018. On average, across countries, rice yield was increased by 2.3 t/ha and the yield gap was reduced by 36%. spnetwork.groupsites.com/folders/271907 https://www.researchsquare.com/article/rs-954093/v1
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)	<ul style="list-style-type: none"> • More efficient use of inputs • Enhanced conservation of habitats and resources • More productive and equitable management of natural resources 	Meta-analysis revealed that relative to the farmer practice, across rice, maize, and wheat, site-specific nutrient management (SSNM) increased grain yield, profit, and partial factor productivity for N by 12, 15, and 26%, respectively. SSNM tool "Rice Crop Manager" generated 2.66 millions fertilizer recommendations in the Philippines (2013 to early 2021) and 250,000 in India (2017 to early 2021). In Burkina Faso, Mali, Nigeria, and Senegal, another SSNM tool "RiceAdvice" generated 109,000 recommendations from 2014 to dry season in 2021. Challenges to scaling of water-saving technologies - AWD (Philippines) and improved water management practices (India, Philippines, Indonesia) were assessed.	2021 - Top 10% of farmers in social groups increase input use efficiencies by 5% at six action sites	Completed	<p>1. Scientific evidence and promotion of mechanized transplanting in Vietnam helped reduce seed rate by 40-60% and pesticide use by 40-50%. 2. P micro-dose placement enhanced P recovery rates (13 to 58%, i.e. 4- to 5-fold) and fertilizer use efficiency for P (110 to 458 g biomass per g P applied; i.e. 9- to 14-fold) compared to broadcast P in Tanzania and Madagascar. 3. Micronutrient application increased incremental benefit:cost ratio by 4-fold in irrigated and 14-fold in rainfed lowland without any soil moisture stress. 4. In Senegal, improved options for salinity management increased partial factor productivity from applied N (PFPN) by 17.8 kg/kg (78%) as compared with farmers practices. Increase in PFPN was not different between male and female farmers. 5. In Senegal, PFPN in farmers fields who received RiceAdvice recommendations was 47 kg/kg as compared to 35 kg/kg in farmers typical practice. 6. JIRCAS's local partners in Madagascar tested the P-dipping technique which is to dip seedling roots into P-enriched slurry at transplanting, in 300 farmers' fields, and confirmed that the technique increases fertilized P use efficiency (P agronomic efficiency) by 98% on average compared to the conventional broadcasting under farmers' practices.</p>	<p>https://www.sciencedirect.com/science/article/pii/S221191242100078X https://doi.org/10.3390/agr4- to 5-fold) and fertilizer use efficiency for P (110 to 458 g biomass per g P applied; i.e. 9- to 14-fold) compared to broadcast P in Tanzania and Madagascar. 3. Micronutrient application increased incremental benefit:cost ratio by 4-fold in irrigated and 14-fold in rainfed lowland without any soil moisture stress. 4. In Senegal, improved options for salinity management increased partial factor productivity from applied N (PFPN) by 17.8 kg/kg (78%) as compared with farmers practices. Increase in PFPN was not different between male and female farmers. 5. In Senegal, PFPN in farmers fields who received RiceAdvice recommendations was 47 kg/kg as compared to 35 kg/kg in farmers typical practice. 6. JIRCAS's local partners in Madagascar tested the P-dipping technique which is to dip seedling roots into P-enriched slurry at transplanting, in 300 farmers' fields, and confirmed that the technique increases fertilized P use efficiency (P agronomic efficiency) by 98% on average compared to the conventional broadcasting under farmers' practices.</p>
F3 Outcome: Options to diversity rice farms with other crops, animals, or trees developed and	<ul style="list-style-type: none"> • Increased livelihood opportunities 	Ecological Engineering (EE) using farmer's preferred vegetable crops on the bunds, enables diversified landscape and pest management benefits in Cambodia. Options to diversify rice during wet-	2021 - Top 10% of farmers in social groups participating in demonstration realize 15% increase	Completed	<p>1. Plots with EE had higher yields without pesticides, compared with conventional practice plots. This also incurred higher cost benefit ratio. 2. Maize is identified as economically viable alternative to rice for northwest India. By substituting CA-based maize for rice, higher profitability</p>	<p>https://grisnetwork.groupsites.com/files/1035354 https://grisnetwork.groupsites.com/files/1035342 https://www.mdpi.com/</p>

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<p>disseminated at six action sites (Cote d'Ivoire, Madagascar, Tanzania, India, Bangladesh, Myanmar) (together with other CRPs)</p>		<p>season identified and evidence of benefits documented in India. Diversified crops including sunflower, maize introduced and disseminated in rice-based system in Bangladesh. Crop diversification options were jointly tested with farmers in Cote d'Ivoire, Madagascar, Senegal, and promising options were identified together with farmers. In Senegal, promising crops are currently under testing in 30 farmers' fields. Data from 4-year experiment comparing different legumes schemes integration of rice bi-annual rotations in Madagascar were analyzed and published.</p>	<p>in farm-derived income through diversification at four action sites</p>		<p>were realized (16%) but transformative improvements in irrigation water saving (84%), energy use efficiency (231% higher), 90% reduction in global warming potential were observed compared to FP. 3. In Madagascar, 5 spp. including carrot, lettuce, pears, spinach, and tomato produced additional income of USD 125 to 1250/ha per off-season which is about 13% to 125% increase in farm income per year depending on the vegetable spp. compared to rice cultivation alone. 4. In Côte d'Ivoire, tomato-rice system generated the highest net income which was more than 6 times higher than the net income of rainfed rice only. 5. In Senegal, economic analysis showed that rice-tomato and rice-onion rotational systems can increase profit by USD 1211 (97%) and USD 4431 (345%), respectively in comparison with rice-rice systems. 6. Legumes based rotation in upland rice systems in Madagascar had the best rice yield, profitability, weed and nematode control and fertility.</p>	<p>2075-4450/12/3/267•https://www.nature.com/articles/s41598-020-76035-z•https://www.sciencedirect.com/science/article/abs/pii/S0308521X20308477•https://www.sciencedirect.com/science/article/abs/pii/S0167880921002802?via%3Dihub•https://grisnetwork.groupsite.com/files/1035348</p>
<p>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)</p>	<p>• Increased access to diverse nutrient-rich foods</p>	<p>On-farm survey for assessing linkage of farm diversification with on-farm diet diversity was analyzed in Madagascar, Nigeria, Rwanda, and Senegal. Crop diversification options were jointly tested with farmers in Cote d'Ivoire, Madagascar, Senegal, and promising options were identified together with farmers. In Senegal, 8 promising crops were selected and are currently testing in 30 farmers' fields.</p>	<p>2021 - Farmers adopting diversified farming systems have diversified diets at four action sites</p>	<p>Completed</p>	<p>1. On-farm survey results showed positive and significant relationship between farm production diversification and dietary diversity in Madagascar, Nigeria, Rwanda, and Senegal. Education levels, farming training and sex of household head were the key drivers of dietary diversity in the households. The findings suggest that encouraging farmers to produce various crop and animal species will contribute to improve better nutritional status among. However, this relationship is complex because it may be influenced other variables such as demographic, socioeconomic, institutional and farm characteristics of households. 2. In Senegal, 8 promising crops were identified together with farmers. They are currently testing in 30 farmers' fields. We will continue with monitoring those farmers for their adoption of crops and diet diversity. 3. IRRRI investigated the adoption of sustainable rice farming practices and its social and cultural impact on rural women in Myanmar through the use of semi-structured interviews. The findings show that adoption</p>	<p>•https://grisnetwork.groupsite.com/files/1037698•https://grisnetwork.groupsite.com/files/1035342•https://www.tandfonline.com/doi/abs/10.1080/09614524.2020.1787350•https://www.tandfonline.com/doi/abs/10.1080/14735903.2021.1918471</p>

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						resulted in a great variety of changes, which have impacted on both a personal level and at a community level. Families use extra income to invest in farming, nutrition (more variety of food) and in their children. Thus, not only farm diversification but also intensification options can also improve diet diversity.	
F3 Outcome: Improved rice management practices that reduce GHG by 5% disseminated at three action sites (Bangladesh, Philippines, Vietnam)	<ul style="list-style-type: none"> 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) 	IRRI developed and validated an IoT based irrigation advisory service (AutoMonPH) decision that entails efficient water management including GHG-reducing water management option - alternate wetting and drying, AWD, continuous monitoring, reporting and verification of water management practices, and a multi-stakeholder interface. Conversation agriculture (CA)-based rice management increased profitability by 13% and energy use efficiency (EUE) by 21% while reducing irrigation by 19% and global warming potential (GWP) by 28%. By substituting CA-based maize for rice, similar mean profitability gains were realized (16%) but transformative improvements in irrigation (- 84%), EUE (+ 231%), and GWP (- 95%) were observed compared to FP.	2021 - Functional outscaling networks and policy support for rice climate-smart technologies that reduce GHG emissions in SE Asia (through CCAFS collaboration)	Completed	1. Alternate wetting and drying (AWD) can reduce water input and GHG without yield penalty. AWD has been disseminated in Bangladesh, Vietnam, China and the Philippines. Among these countries, AWD has been integrated in major national rice crop management guidelines in Vietnam, China and the Philippines. Challenges to scaling of AWD were assessed in the Philippines and Bangladesh, and lessons learned were described for improving scaling approaches. 2. "One-Must-Do, Five-Reductions" that can reduce GHG through reduced water use reached at least 104,448 farmers in Vietnam. 3. Laser-controlled land leveling (LLL), which could reduce 10-20% direct methane emissions due to stagnant water, was certified as an "Advanced Agricultural Technology" by the Ministry of Agricultural and Rural Development in Vietnam. It is also included in the "One-Must-Do, Five Reductions" which is the Vietnam Best Management Practice. 4. The digital rice management advisory tool Rice Crop Manager (RCM) enables farmers and extension agents to calculate field-specific rates of fertilizer N, P, and K for rice, and could reduce GHG. The transfer of digital rice management advisory tool Rice Crop Manager (RCM) to the Depy of Ag. in the Philippines is a critical step in the process of scaling.	<p>•https://www.frontiersin.org/articles/10.3389/fsufs.2021.675818/full•https://www.mdpi.com/2073-4441/12/5/1510•https://drive.google.com/file/d/1wmxCe724XdgDgoHoS0_19i6NWybnLoEY/view•https://www.nature.com/articles/s41598-020-76035-z•https://marlo.cgiar.org/projects/Rice/studySummary.do?studyID=2861&cycle=Reporting&year=2021•https://marlo.cgiar.org/projects/Rice/innovation.do?innovationID=2386&edit=true&phaseID=349&crop=Rice•https://marlo.cgiar.org/projects/Rice/innovation.do?innovationID=2387&projectID=1581&edit=true&phaseID=349•https://www.mdpi.com/2073-4395/11/9/1707•https://drive.google.com/file/d/1HDmNXf7oVpghzUK4cDN76IbAbOQT-j8/view•https://marlo.cgiar.org/projects/Rice/innovation.do?innovationID=2387&projectID=1581&edit=true&phaseID=349</p>	

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							ar.org/projects/Rice/studySummary.do?studyID=2741&cycle=Reporting&year=2021
	<p>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)</p>	<ul style="list-style-type: none"> Enhanced capacity to deal with climatic risks and extremes (Mitigation and adaptation achieved) 	<p>WeRise is a web-based, seasonal climate prediction-based decision support system for rainfed rice farmers through integration of statistical downscaling model of GCM and crop growth model. On-farm validation of WeRise in Indonesia and the Philippines showed that on average it increased rice yield and partial factor productivity for N by 16 and 81%, respectively. WeRise manual for researchers was published to support researchers for their application of this ICT to improve rainfed rice research. The manual for agricultural extension workers was also published to guide local users for proper application of this ICT to improve rainfed rice production.</p>	<p>2021 - In collaboration with the Sustainable Rice Platform, results of assessment of multidimensional sustainability indicators communicated to national policy framework</p>	<p>Completed</p>	<p>1. Results of assessment of multidimensional sustainability indicators jointly collected with GIZ project (CARI) communicated to private and public partners in Burkina Faso, Nigeria, and Tanzania. Report on GIZ-CARI SRP Validation Workshop in Nigeria is available, but not for other countries yet. 2. Paper on assessment of multidimensional sustainability indicators in Africa was published and shared with AfricaRice partners.3. Sustainability targets for irrigated rice production in Asia were identified using data from the Sustainable Rice Platform performance indicators, and results were shared through publisher webpage and SNS.</p>	<p>•https://www.sciencedirect.com/science/article/pii/S0378429021002094•https://grispnetwork.groupsites.com/files/1035347•https://www.jircas.go.jp/site/default/files/publication/jircas_working_report/jircas_working_report92_-_.pdf•https://www.mdpi.com/2077-0472/11/4/346•https://www.sciencedirect.com/science/article/abs/pii/S0195925521001475?dgcid=coauthor</p>
	<p>F3 Outcome: Value chain actors including farmers and service providers using new mechanization options designed to increase women's labor productivity at seven action sites (Nigeria, Senegal, Tanzania, Vietnam, Indonesia, Bangladesh,</p>	<ul style="list-style-type: none"> Technologies that reduce women's labor and energy expenditure adopted 	<p>In Bangladesh, the nonchemical option with mechanical weeding and one hand-weeding reduced labor requirement by 6 to 9 person-day ha⁻¹, and performed similarly to farmers' practice on yield and profitability. Mechanized direct seeding coupled with tailored best bet agronomy was developed and demonstrated in four provinces of Cambodia. Mechanized rice cultivation (direct seeded rice or mechanical transplanted rice) refined and demonstrated in India. In</p>	<p>2021 - Top 10% female farmers benefit from labor-saving technologies at two action sites</p>	<p>Completed</p>	<p>1. Female farmers in Myanmar benefited from adoption of best management practices including mechanization options. They increased income through rice production and got extra time. They reported that they have more time to devote to their small-scale businesses such as shops, home gardens, or farming of other cash crops. Farmers were also able to spend more time on community activities, which appear to strengthen community bonds and contribute to improved infrastructure, such as roads. 2. Between 2019 – 2021, 38 machineries (22 weeders, 12 threshers, 2 winnowers) were distributed to different associations of value chain actors (seed producers, farmers, parboilers), with a target to reach 478</p>	<p>•https://grispnetwork.groupsites.com/files/1035352•https://grispnetwork.groupsites.com/files/1035349•https://www.cambridge.org/core/journals/weed-Farmers were also able to spend more time on community activities, which appear to strengthen community bonds and contribute to improved infrastructure, such as roads. 2. Between 2019 – 2021, 38 machineries (22 weeders, 12 threshers, 2 winnowers) were distributed to different associations of value chain actors (seed producers, farmers, parboilers), with a target to reach 478</p>

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	Myanmar)		Madagascar, Rice seeders and Fertiseeder reduced the labour input for sowing by 70-80%. Awareness about these machines created through fairs and farmers showed interest in buying them. Fabrication and dissemination being done by the local fabricators.			persons, 60% are women. The users reported that these machineries reduced labor inputs and generated additional income.	bangladesh/D7A5F0561C CD7DD946E7CCB44D7C2 174• https://www.tandfonline.com/doi/full/10.1080/09614524.2020.1787350
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.	<ul style="list-style-type: none"> Enhanced adaptive capacity to climate risks (More sustainably managed agro-ecosystems) 	The focus during 2021 has been on data curation and analyses. Work is ongoing to finalize these for manual and UAV phenotyping on the reference panels. With the AP data we identified 7 Mega-Environemenst and sensor varieties for biotic and abiotic stresses. For CoA 3, additional studies of pathogen population diversity for rice yellow mottle virus (Africa) and sheath blight (Asia) were accomplished with publications in preparation. The PathoTracer tool was used extensively by partners in SE Asia. Varieties from the antena panel were used by NARES breeding programs(India ,Raipur; Vietnam,CLRRI;Bangladesh, BRRl).	2021 - GxE analysis of the antenna data is completed	Partially Complete	Data analyses were completed, publication of the results will occur in 2022.	• https://sites.google.com/irri.org/globalricearray/home
	F4 Outcome: A functional global phenotyping network composed of 30% non-CRP partners (including self-sponsored), and genetic donors (>10) and ideotypes (2-4) adopted by breeding programs to develop	<ul style="list-style-type: none"> Adoption of CGIAR materials with enhanced genetic gains 	A few additional trials of the reference panel were completed at partner sites during 2021. All data across sites was compiled and site-specific GWAS analyses for yield, plant height, and flowering time were accomplished. The GWAS and statistical analyses, along with information from the site clustering from antenna panel data, allows selection of best lines for the seven environmental clusters. Cross-site GWAS accounting for	2021 - Global phenotyping data curated and made available to global community through the integrative rice data hub and genetic donors made available to breeding programs	Completed	We have updated the project website (see https://sites.google.com/irri.org/globalricearray/home). This project site serves as a datastore by incorporating access to trial data and the panel SNP data.	• https://sites.google.com/irri.org/globalricearray/home

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climate-smart rice varieties		GxE is ongoing. A new reference panel could not be deployed.				
F4 Outcome: Characterized pathogens populations and diversity used to predict varietal deployment for at least 3 major rice diseases	<ul style="list-style-type: none"> Enhanced capacity to deal with climatic risks and extremes (Mitigation and adaptation achieved) 	Pathogen populations have been characterized for blast and bacterial leaf blight in Asia, and blast and rice yellow mottle virus in E. Africa. Additionally, the diversity of brown spot and sheath blight populations has been characterized.	2021 - Efficiency of available disease (RYMV, Blast, BLS and BLB) resistance genes validated and characterized soil microbiome for specific sites.	Completed	Webtool for Pathogen tracing published (https://doi.org/10.1101/2020.11.17.377325), and eight related publications produced and in press. Tools developed for microbiota identification and inoculations were used to study the adaptation of AP varieties to test the impact on the microbiome of the origin of seeds and see how the bacterial isolates can be used as natural enhancers for plant adaptation.	https://doi.org/10.1186/s12284-020-00432-1
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	<ul style="list-style-type: none"> Adoption of CGIAR materials with enhanced genetic gains 	GWAS analyses of the reference panel for the different sites and trials have identified significant peaks for height, heading, and yield. Once, integrated analyses for GxE, lines stable across environmental clusters can be determined. These analyses were expected to occur within 2022, enabling selection of environment-specific donors.	2021 - Candidate genes identified and QTL/genes and donors validated across environments	Partially Complete	Completing this component requires that other components still under way be finalized so that results can be interpreted. Donor validation across environments remains a future activity that breeders and researchers will need to undertake.	
F4 Outcome: A functional open access rice data hub that allows Global users to fast track their research by exploiting available phenotypic and genotypic	<ul style="list-style-type: none"> Increased conservation and use of genetic resources 	An updated project site that also serves as a datastore was made available (see https://sites.google.com/irri.org/globalricearray/home). For UAV data, an instance of ImageBreed database has been created. The Crop Galaxy site has been maintained with updated tools, datasets, and documentation (http://croplaxy.excellenceinbreeding.org	2021 - Analytical tools to enable predictive and decision-making processes and completely curated datasets are integrated in the rice data hub and made	Partially Complete	Completely curated datasets are available from the data hub. Tools for GxE and GWAS are available from Crop Galaxy. However, decision support tools need to be integrated into the data hub.	https://sites.google.com/irri.org/globalricearray/h

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	information and data analysis tools		g).	accessible to the global community			
F5	F5 Outcome: Rice diversity in rice gene banks used globally for identification of traits and discovery of new genes	<ul style="list-style-type: none"> Increased conservation and use of genetic resources 	Much progress has been made to identify novel donors and genes using diverse genetic resources. In 2021, studies involving anaerobic germination, blast, drought, salinity, grain Zn and Fe, cadmium uptake, grain arsenic, nitrogen deficiency and others were published providing additional evidence for uptake by breeding. Sequencing of the indica elite breeder's pool enables haplotype analyses of the alleles to determine which already occur or need to be introgressed.	2021 - 60% of targeted traits/donors/QTLs/genes identification achieved, 100% of the new diversity analysis accessions sequenced	Completed	Flagship activities were able to deliver many publications on novel alleles, new candidate genes and donors, and supporting information for a range of traits related to climate change, disease resistance, and human nutrition and health.	<ul style="list-style-type: none"> https://www.mdpi.com/2223-7747/10/4/705 https://www.frontiersin.org/articles/10.3389/fpls.2021.753063/full https://www.frontiersin.org/articles/10.3389/fpls.2021.647341/full
	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		Progress on deployment of early-maturity genes has proceeded apace, with target recovery of the elite genomic background being achieved and all genes having recombinants on at least one side. A minor amount of work is ongoing to identify recombinants on the second side of 2 genes, results are expected this month. Fine-mapping of the qSIS1.2 QTL has refined this interval from around 400kb to around 100kb, so one quarter the size. Upgraded marker systems based on the refined QTL interval have already been implemented at Agriplex and Intertek for use in breeding.	2021 - 75% of the targeted breeding tools and resources developed and used in breeding programs. Use of gene editing for the validation of the RHBV virus disease resistance gene for LAC based on genetic diversity studies	Completed	Progress on deployment of early-maturity genes has proceeded apace, with target recovery of the elite genomic background being achieved and all genes having recombinants on at least one side. A minor amount of work is ongoing to identify recombinants on the second side of 2 genes, results are expected this month. Fine-mapping of the qSIS1.2 QTL has refined this interval from around 400kb to around 100kb, so one quarter the size. Phenotyping is currently challenging due to COVID restrictions, but an additional round of recombinant selection has been done, and when phenotyping data is available this will narrow the interval to potentially a few tens of kilobases, which will enable unambiguous identification of the candidate gene. In the meantime upgraded marker systems based on the refined QTL interval have already been implemented at Agriplex and Intertek for use in breeding.	<ul style="list-style-type: none"> https://docs.google.com/spreadsheets/d/14zoNDsJ61TwoeeloXx6y-vF_V2UdbyajOQUBEWSNxF0/edit#gid=0

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<p>F5 Outcome: New rice varieties resulting in 1.3 % genetic gain in intensive systems</p>	<ul style="list-style-type: none"> Adoption of CGIAR materials with enhanced genetic gains 	<p>The program is on track in delivering genetic gains above 1%. A recent genetic gains analysis on the data from 2016 to 2020 shows a genetic gain of 1.21% per year. With the steps taken to reduce the breeding cycle length, improved trialing and breeding pipeline reorganization based on market segments is expected to further increase the rate of genetic gain. In addition, a total of 11 varieties were released in 2021.</p>	<p>2021 - Genetic gains at the end of the breeding cycle of 1% compared to 2016; 10 varieties released with 10% higher yield, and meeting national quality requirements, in intensive systems.</p>	<p>Completed</p>	<p>The program is on track in delivering genetic gains above 1%. A recent genetic gains analysis on the data from 2016 to 2020 shows a genetic gain of 1.21% per year. With the steps taken to reduce the breeding cycle length, improved trialing and breeding pipeline reorganization based on market segments is expected to further increase the rate of genetic gain. In addition, a total of 11 varieties were released in 2021.</p>	<p>•https://drive.google.com/drive/u/0/folders/17hUbsvajte6vzeUy7t5NROGkk1mWVqyo•https://drive.google.com/drive/u/0/folders/17hUbsvajte6vzeUy7t5NROGkk1mWVqyo</p>
<p>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</p>	<ul style="list-style-type: none"> Enhanced capacity to deal with climatic risks and extremes (Mitigation and adaptation achieved) 	<p>Rice varieties suitable to rainfed environments and direct seeding are continuously being developed through various breeding pipelines. The activity particularly targets development of high yielding stress tolerant breeding lines for various geographies across Asia and Africa and ensuring a continuous inflow into variety release pipelines of the target countries. These efforts have led to the release of stress tolerant rice varieties in countries such as India, Bangladesh, Nepal, and the Philippines.</p>	<p>2021 - 20, 15, 10% reduction in risk of yield loss in elite cultivars at the end of breeding cycle caused by factors induced by climate change, in mega deltas, rainfed lowlands, and uplands, respectively</p>	<p>Completed</p>	<p>Rice varieties suitable to rainfed environments and direct seeding are continuously being developed through various breeding pipelines which are a part of the CoA 5.4. The activity particularly targets development of high yielding stress tolerant breeding lines for various geographies across Asia and Africa and ensuring a continuous inflow into variety release pipelines of the target countries. These efforts have led to the release of stress tolerant rice varieties in countries such as India, Bangladesh, Nepal, and the Philippines. Further, a number of breeding lines in the released pipeline in countries such as Sri Lanka, Tanzania, Mozambique, Kenya, Vietnam, Indonesia, and Lao PDR. These are likely to be tested and released in the next 2 years time and will help in combating abiotic stresses affecting rice production in these countries. A list of released varieties is regularly updated by the countries in their respective websites. IRRI also makes a continuous effort in profiling some of these products and making the information available to the partners. The information can be accessed at the Global Product Repository managed by IRRI.</p>	<p>•https://globalproductrepository.irri.org/</p>
<p>F5 Outcome: High quality and high</p>	<ul style="list-style-type: none"> Increased access to 	<p>We investigated the in vitro glycaemic index (GI) of breeding material and found</p>	<p>2021 - Slower digestible and low</p>	<p>Completed</p>	<p>We investigated the in vitro glycaemic index (GI) of breeding material and found that many of them are in the</p>	<p>•https://onlinelibrary.wiley.com/doi/10.1111/pbi</p>

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<p>nutritious rice varieties that are preferred by men and women farmers and consumers</p>	<p>diverse nutrient-rich foods</p>	<p>that many of them are in the high GI ranges. To find the donor lines we have screened 320 gene bank material and identified 3 low GI donor lines. These lines are validated through human feeding trials and confirmed its in vivo GI as low GI. Interestingly one low GI line was found to possess soft texture upon conducting sensory analysis.</p>	<p>glycemic index rice lines and process products donors utilized to identify loci affecting low GI</p>		<p>high GI ranges. To find the donor lines we have screened 320 gene bank material and identified 3 low GI donor lines. These lines are validated through human feeding trials and confirmed its in vivo GI as low GI. Interestingly one low GI line was found to possess soft texture upon conducting sensory analysis. Based on genome wide association we identified target genes GBSSI, two hydrolase genes, genes involved in signaling and chromatin modification confer to lower the GI. The superior haplotype defined from these target genes were scanned in 94 breeding lines and identified two low to intermediate GI breeding lines. The modern breeding lines IRRI 147 and IRRI 162 in vivo GI values were in the range of 55 and 57, respectively. The low GI germplasm possessed superior haplotypes for OsTPR haplotypes conferring higher upper secondary rachis branching accounting a total yield of 6.40 tons/ha and 6.9 tons/ha, respectively.</p>	<p>13560•https://onlinelibrary.wiley.com/doi/10.1111/pbi.13051</p>
<p>F5 Outcome: Standardized design, data collection, analysis and management implemented across the program</p>	<p>• Increased conservation and use of genetic resources</p>	<p>Covid-19 restrictions on data acquisition on site to develop a variety turn-over atlas. Instead, we focused on developing new methods to estimate genetic gain in farmers' fields. We developed a new scheme for On Farm Trails (OFT), where each farm is a block or replicate. It will allow us to run joint analysis per year and also combine many years of data. Consequently, we can increase the reliability and estimate genetic trends (variety replacement effect) at the farmer's level over the years.</p>	<p>2021 - Atlas of variety turn-over rates in farmers fields for major rice growing regions of the world. Indicators for the breeding program and genetic gains according to product profiles</p>	<p>Changed</p>	<p>We developed a new scheme for On Farm Trails (OFT), based on animal breeding analysis and RCBD, where each farm is a block or replicate. It will allow us to run joint analysis per year and also combine many years of data. Consequently, we can increase the reliability and estimate genetic trends (variety replacement effect) at the farmer's level over the years. Another initiative was to optimize the trial system based on enviromics. Consequently, we could reorganize the allocation in a better way and reduce in ⅓ the number. Finally, we developed an analytical pipeline on R to optimize OFT and analyze datasets, ready to implement EBS. Concerning the breeding trials, we have worked similarly, optimizing the number and allocation of trials, moving towards sparse design for breeding materials in NARS sites, and developing a breeding analytics pipeline on R, combining genomic prediction and selection index (for QTL and quantitative traits), based on stochastic simulation and empirical data.</p>	<p>•https://globalproductrepository.irri.org/</p>

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

	Number	Percent
Peer-Reviewed publications	369	100%
Open Access	274	74%
ISI	343	93%

Table 7: Participants in CapDev Activities

Number of trainees	Female	Male
In short-term programs facilitated by CRP/PTF	14,501	28,859
In long-term programs facilitated by CRP/PTF	89	147
PhDs	41	60

Evidence Link: <https://grispnetwork.groupsite.com/files/1041722>

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	The Council for Partnerships on Rice Research in Asia guides, facilitates, supports and strengthens the partnerships between and among the NARES in Asia, and IRRI.	<ul style="list-style-type: none"> • IRRI - International Rice Research Institute • BARC - Bangladesh Agricultural Research Council • CARDI - Cambodian Agricultural Research and Development Institute • MAFF - Ministry of Agriculture, Forestry and Fisheries (Cambodia) • CNRRI - China National Rice Research Institute • ICAR - Indian Council of Agricultural Research • IAARD - Indonesian Agency for Agricultural Research and Development • JIRCAS - Japan International Research Center for Agricultural Sciences • NAFRI - National Agriculture and Forestry Research Institute • MARDI - Malaysian Agricultural Research and Development Institute • MOALI - Ministry of Agriculture, Livestock and Irrigation (Myanmar) • NARC - Nepal Agricultural Research Council • PARC - Pakistan Agricultural Research Council • RDA - Rural Development Administration (Korea) • RRDI - Rice Research and Development Institute • MOAC - Ministry of Agriculture and Cooperatives (Thailand) • VAAS - Vietnam Academy of Agricultural Sciences 	<ul style="list-style-type: none"> • Policy • Capacity Development • Delivery • Research
F1	CARD is a consultative group of bilateral donors and regional and international organizations working with rice-producing countries in sub-Saharan Africa aiming to increase rice production to 56 millionMT by 2030.	<ul style="list-style-type: none"> • JICA - Japan International Cooperation Agency • AfricaRice - Africa Rice Center • IRRI - International Rice Research Institute • AfDB - African Development Bank Group • FAO - Food and Agriculture Organization of the United Nations • AGRA - Alliance for a Green Revolution in Africa 	<ul style="list-style-type: none"> • Policy

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		<ul style="list-style-type: none"> • FARA - Forum for Agricultural Research in Africa • IFAD - International Fund for Agricultural Development • JIRCAS - Japan International Research Center for Agricultural Sciences • WFP - World Food Programme • The World Bank • NEPAD - New Partnership for African Development • IDB - Islamic Development Bank 	
F2	The Sustainable Rice Platform is a global multi-stakeholder alliance that promotes climate-change resilience in rice systems, and pursues voluntary market transformation initiatives by developing sustainable production standards, indicators, outreach mechanisms	<ul style="list-style-type: none"> • GIZ - Deutsche Gesellschaft für Internationale Zusammenarbeit / German Society for International Cooperation • PhilRice - Philippine Rice Research Institute • Mars, Incorporated • Kellogg • UNEP / UN Environment - The United Nations Environment Programme • Olam - Olam International • AfricaRice - Africa Rice Center • IRRI - International Rice Research Institute 	<ul style="list-style-type: none"> • Research • Research
F3	The Direct Seeded Rice Consortium is a public-private multi-stakeholder research for development platform on direct seeded rice, convened by IRRI in 2017 and with members across Asia and the Pacific.	<ul style="list-style-type: none"> • IRRI - International Rice Research Institute • BASF - BASF SE • Bayer Crop Science • Corteva AgriScience • JISL - Jain Irrigation Systems Ltd. • CARDI - Cambodian Agricultural Research and Development Institute • ICAR-CAFRI - Indian Council of Agricultural Research - Central Agroforestry Research Institute • CNRRI - China National Rice Research Institute • MARDI - Malaysian Agricultural Research and Development Institute • IFA - International Fertiliser Association • IPNI - International Plant Nutrition Institute • NARC - Nepal Agricultural Research Council • PARC - Pakistan Agricultural Research Council • PhilRice - Philippine Rice Research Institute 	<ul style="list-style-type: none"> • Delivery • Research

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		<ul style="list-style-type: none"> • Syngenta 	
F3	The Sustainable Rice Platform is a global multi-stakeholder alliance that promotes climate-change resilience in rice systems, and pursues voluntary market transformation initiatives by developing sustainable production standards, indicators, outreach mechanisms	<ul style="list-style-type: none"> • UNEP / UN Environment - The United Nations Environment Programme • IRRI - International Rice Research Institute • AfricaRice - Africa Rice Center • GIZ - Deutsche Gesellschaft für Internationale Zusammenarbeit / German Society for International Cooperation • Olam - Olam International • PhilRice - Philippine Rice Research Institute • Mars, Incorporated • Kellogg 	<ul style="list-style-type: none"> • Delivery • Other
F4	Collaboration on development of techniques for Unmanned Aerial Vehicle (UAV) based phenotyping was extended to partners at the Taiwan Agricultural Research Institute	<ul style="list-style-type: none"> • COA - Council of Agriculture (Taiwan) 	<ul style="list-style-type: none"> • Research • Research
F5	The Hybrid Rice Development Consortium is made up of public and private organizations and institutes to promote innovation and access to new germplasm and information on hybrid rice technology.	<ul style="list-style-type: none"> • FCRI - Field Crops Research Institute • ICRR - Indonesian Center for Rice Research • Bioversity (Alliance) - Alliance of Bioversity and CIAT - Headquarter (Bioversity International) • IRRI - International Rice Research Institute • Advanta Seeds Pvt. Ltd. • Bayer Crop Science • Corteva AgriScience • ICAR - Indian Council of Agricultural Research • AATF - African Agricultural Technology Foundation • AfricaRice - Africa Rice Center • BRRI - Bangladesh Rice Research Institute • CNRRI - China National Rice Research Institute • BAU - Bangladesh Agricultural University 	<ul style="list-style-type: none"> • Delivery • Capacity Development • Research

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F5	The ASEAN RiceNet establishes a new germplasm exchange and evaluation network for ASEAN and Plus-3-Dialogue Partner countries. It supports the ASEAN region to evaluate and release climate resilient rice varieties..	<ul style="list-style-type: none"> • VAAS - Vietnam Academy of Agricultural Sciences • NAFRI - National Agriculture and Forestry Research Institute • CARDI - Cambodian Agricultural Research and Development Institute • MARDI - Malaysian Agricultural Research and Development Institute • ICRR - Indonesian Center for Rice Research • MOALI - Ministry of Agriculture, Livestock and Irrigation (Myanmar) 	<ul style="list-style-type: none"> • Capacity Development • Delivery • Research
F5	The Latin American Fund for irrigated Rice, FLAR, is a public-private partnership that seeks to improve the competitiveness and sustainability of rice production systems, with an eco-efficiency approach.	<ul style="list-style-type: none"> • INTA - Instituto Nicaragüense de Tecnología Agropecuaria • INIA - Instituto Nacional de Investigación Agropecuaria (Uruguay) • INIA - Instituto Nacional de Investigaciones Agrícolas (Venezuela) • SENUMISA - Semillas del Nuevo Milenio S.A. • Semillas El Potrero • Alliance of Bioversity International & the International Center for Tropical Agriculture (CIAT) • IRGA - Instituto Rio Grandense do Arroz • FEDEARROZ - Federación Nacional de Arroceros • INTA - Instituto Nacional de Innovación y Transferencia en Tecnología Agropecuaria 	<ul style="list-style-type: none"> • Capacity Development • Delivery • Policy • Research
F5	The International Rice Informatics Consortium provides access to well-organized information about rice, and to facilitate communication and collaboration for rice community, having germplasm diversity as a focal entry point.	<ul style="list-style-type: none"> • Syngenta • KAUST - King Abdullah University of Science and Technology • IRD - Institut de Recherche pour le Développement • CIRAD - Centre de coopération internationale en recherche agronomique pour le développement • University of Western Australia • NTU - National Taiwan University • LSU Louisiana - Louisiana State University • IRRI - International Rice Research Institute • Alliance of Bioversity International & the International Center for Tropical Agriculture (CIAT) • Cornell University • NIAB - National Institute of Agricultural Botany • Bayer Crop Science 	<ul style="list-style-type: none"> • 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
Foresight analyses	PIM	scientific
Collaboration on tools and methodologies to strengthen gender components/analyses in research. In 2021, two projects of the gender platform were initiated that are linked to RICE activities: 'Exploring women's empowerment pathways in water governance for better livelihoods in Bangladesh', and 'Gender and empowerment inquiry into the downstream rice value chain'.	Gender	scientific
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
Food system and nutrition research	A4NH	scientific
Market and value chain research	PIM	scientific
Development and dissemination of climate-smart agricultural practices (such as Alternate Wetting and Drying, stress-tolerant rice varieties; mitigating GHG emissions or assisting farmers with adaptation), and development of policies that support adoption of such practices; development and use of tools to compute GHG emissions from rice fields under climate-smart practices.	CCAFS	Development and dissemination of climate-smart agricultural practices (such as Alternate Wetting and Drying, stress-tolerant rice varieties; mitigating GHG emissions or assisting farmers with

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		adaptation), and development of policies that support adoption of such practices; development and use of tools to compute GHG emissions from rice fields under climate-smart practices
Excellence in Agronomy 2030 Initiative was launched in 2020, with a 2-yr incubation project has been funded by BMGF. In 2021, most effort was spent on developing the post-CRP OneCGIAR initiative 'Excellence in Agronomy'.	BIOVERSITY, CIMMYT, IRRI, CIP, ICARDA, IITA, AfricaRice	scientific, delivery
Co-development of pre-breeding and breeding tools (data bases, genomic analysis)	EiB	scientific
Development and dissemination of biofortified rice (zinc, iron, pro-vitamin A)	A4NH	scientific, delivery
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	EiB	scientific

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
S2757 - Empowerment of rural women in Senegal, Cote d'Ivoire and Madagascar	On-going	Program/project adoption or impact assessment	In Cote d'Ivoire and Madagascar empowering the rural women not only make them economically empowered but also help them to get credit for productive work. In Nigeria, it is possible for women to run profitable businesses, but some constraints remain: lack of awareness, skills, capital, basic business tools/equipment, and the perception of gender-specific nature of some activities. Within the COVID19 context, production kits will be provided to vulnerable women to facilitate their access to inputs and enhance their resilience.	
S2758 - Seed and variety dissemination roadmaps in Africa	On-going	Program/project adoption or impact assessment	Seed and variety dissemination roadmaps were developed for Burkina Faso, Gambia, Guinea, Mali, Nigeria, Sierra Leone, Ethiopia, Uganda, and Madagascar. In Cote d'Ivoire and Guinea, 20 tons of quality seeds were produced and disseminated to partners to increase capacity at the national level. AfricaRice is leading the seed delivery component of the Regional Rice Value Chain Program (RRVCP) funded by the IsDB to strengthen/develop regional network of seed developers constituted by the national agricultural research centers in each of these countries.	
S3266 - Promotion of youth employment in the rice value chain in	On-going	Program/project evaluation/review	Inclusive collaboration with the national initiatives on youth employment, international organization (MasterCard Foundation, GIZ, Syngenta Foundation), farmers organizations, private sector, and national agricultural bank to sensitive the youth on the business opportunities and the creation of enterprises along the rice value chain. The program also	

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Africa			includes capacity building of youth on entrepreneurship, technical activities along the rice value chain, development of the business plan, coaching/mentoring, and financial support to create enterprises. Analysis of youth ICT use and impact.	
S3546 - Impact of COVID 19 on rice sector: simulation of different economic slowdown and recovery scenarios	Cancelled	Ex-ante, baseline and/or foresight study	This activity examines the projected impacts of the COVID19 pandemic on rice consumption, production, prices, and trade using simulation of different economic slowdown and recovery scenarios using the IRRI Global Rice Model (IGRM). In doing so, this foresight activity relies on improving the estimation of the rice per capita consumption of the country models in the IGRM with respect to income and price elasticities of demand. It also relies on updating IGRM with recent data and developing a new baseline that would be needed in conducting simulations of various economic slowdown and recovery scenarios.	
S3547 - The impacts of reforming agricultural policy support on cereals prices: A CGE Modeling Approach	Completed	Ex-ante, baseline and/or foresight study	This paper examines the effects of the expected reforms of agricultural support policies on cereal prices in several countries. In doing so, we simulate a scenario on the total abolition of all agricultural subsidies using the GTAP model and focus on 27 countries and 7 regional aggregates. We consider two alternative scenarios: (1) removal of subsidies on (a) output, (b) primary input, (c) domestic intermediate input, and (d) imported intermediate input in all agricultural sectors; (2) removal of border tariffs in all agricultural sectors. The simulation results suggest that the removal of agricultural subsidies would increase the price of cereals in all of the sample countries.	https://ageconsearch.umn.edu/record/313939/
S3548 - Modernization and Transformation of rice in Asian economies	Completed	Ex-ante, baseline and/or foresight study	The study considers three different scenarios- 1. Transformation and Modernization 2. Increasing the resilience of the rice sector 3. Liberalization of the rice sector and reducing trade policy distortions. When rice sector is modernized and transformed, the GDP of Laos (3.85%), Cambodia (1.23%), Pakistan (1.30%), Bangladesh (1.10%), Thailand (0.57%), Philippines (0.50%), Nepal (0.50%), India (0.22%), and Brunei (0.14%), increases significantly. All these countries have a higher shock as a result of higher difference between their current yield level and the one that is estimated as a result of modernization benchmarking China. On the other hand, the GDP of Egypt which is the	https://grisnetwork.k.groupsie.com/

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			largest producer of rice in Africa is expected to decline by 0.18%. Modernization in rice sector increases the output of rice in most Asian countries – Cambodia (23.22%), Thailand (20.12%), Pakistan (12.70%), Laos (6.12%), Nepal (5.64%), Bangladesh (3.89%), Brunei (3.74%), Philippines (2.61%), and India (2.52%).	
S3549 - Potential effects of the EU-Vietnam Free Trade Agreement on rice trade and welfare	Cancelled	Ex-ante, baseline and/or foresight study	The activities include: (i) preparation of medium-term baseline projections or market outlook on rice supply, demand and prices for major rice-producing and-consuming countries, (ii) simulation of the different EU-Vietnam Free Trade Agreement scenarios, and (iii) analysis of the effects on rice production, consumption, prices, trade and trade diversion.	
S3550 - Prioritization of agricultural research for poverty impact: An application to the Philippines	Completed	Ex-ante, baseline and/or foresight study	This study presents a method for prioritizing commodities for agricultural research based on the impact on household income and poverty reduction. This approach uses simple partial equilibrium methods to measure the impact of the yield growth on prices and output. Using nationally-representative household survey data on the contribution of each crop to income and the share of consumption in the budget, we estimate the impact on income for each household. These results are aggregated to estimate the impact on average income and on headcount poverty. Finally, these calculations are repeated for thousands of possible allocations of the research budget across the crops being analyzed. The method is illustrated using data on rice, maize, cassava, coffee, and vegetables in the Philippines from the 2012 Family Income and Expenditure Survey. Furthermore, unless there are substantial diminishing marginal returns to investment in crop technology, rice merits the lion’s share of research investment.	https://grisnetwork.k.groups.com/
S3551 - Modelling the Impacts of Agricultural Policy Support on GHG Emissions in the rice sector	Completed	Ex-ante, baseline and/or foresight study	This study simulated the effects of the reforms in agricultural policy support on three types of emissions: carbon dioxide (CO2) emissions, non-CO2 emissions and total air pollution. Simulation results based on the removal of subsidies in all agricultural sectors suggest an increase in all agricultural prices, and reduction in their output and consumption, as well as in the emissions. For the scenario on the removal of border measures, the results indicate a decrease in all agricultural prices and increase in their	https://grisnetwork.k.groups.com/

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			consumption, and CO2 emissions. There were exceptions to both results broadly, and they were mainly due to the lower subsidies and tariffs. Overall, the results for the rice sector confirm that direct subsidy measures are worse for the environment than border measures. This finding has an important policy implication insofar as it would contradict the traditional ranking of harmful policy support measures based on trade impacts.	
S3552 - Explaining rice export price differentials	Completed	Other MELIA activity	This study analyzed the price differentials, magnitude and speed of adjustment of different rice quality types: aromatic, Indica higher quality, and Indica lower quality rice. The composition of potential convergence club formation of price differential for each of these rice quality types was analyzed in the context of increasing market segmentation in the different rice quality markets. The results suggest that there is weak evidence that the law of one price for rice holds in the long-run. The probability of a converged pairing increases for any two rice varieties that are both fragrant or from the same country. Also, the more similar is the market share then the greater is the probability of convergence. A faster speed of adjustment is associated with rice pairing that are from the same country or where both varieties are fragrant. Differences in market share lead to a reduction in the speed of adjustment.	https://grisnetwork.k.groupsitem.com/?flash_top=true
S3553 - Randomized control trial (RCT) to assess alternative delivery pathways to enhance the uptake of Rice Crop Manager	Cancelled	EPIA: Ex-post Impact Assessment	Known effective dissemination approaches to enhance the uptake of RCM will be piloted using one current and two alternative delivery pathways. These are (i) government-facilitated (current practice), (ii) State University and Colleges (SUC)-facilitated and (iii) private sector-facilitated. For the private sector-facilitated pathway, we will tap fertilizer dealers and credit providers in each province to participate in the RCT.	There is no MELIA publication at the moment
S3557 - Support for the creation of service businesses by young people	On-going	Qualitative Outcome Study: (mainly to substantiate contribution to	agCelerant™ is a multiservice digital tool developed by Manobi Africa that aims to better orchestrate the rice value chain by derisking the transactions and engaging the private sector and the financial services. The youth will be trained and provided with smartphones and motorbikes to provide paid services to farmers and other stakeholders.	

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		policy or similar)	The youth activities include the registration of farmers, georeferencing, data collection (crop calendar, input needs, on-farm management, production, available stock, etc.), and facilitation of their transactions with their customers and suppliers (orders, delivery, invoicing, collection, etc.).	
S3558 - Social impacts of chemical weed management	Cancelled	Ex-post adoption study	Data for this study will be collected through Telephonic survey data.	
S3559 - DSR adoption and impact of residue burning	On-going	Program/project adoption or impact assessment	Data will be collected on DSR adoption. Crop cut will be implemented. An experiment will be conducted on No burn policy to collect data.	
S3607 - Efecto de la pandemia del COVID-19 en el sector arrocero de America Latina y el Caribe	Completed	Qualitative Outcome Study: (mainly to substantiate contribution to policy or similar)	Current health conditions have affected diverse sectors, and the effects of COVID in LAC have been heterogeneous across the region. Generating awareness of the main limitations during this period is vital to improving policy designs for the rice value chain	https://cgspace.cgiar.org/handle/10568/108967
S3608 - Salt-tolerant rice variety adoption in the Mekong River Delta: Farmer adaptation to sea-level rise	Completed	Ex-post adoption study	This paper examines the diffusion of salt tolerant rice varieties in the MRD that were promoted through CURE activities. Factors associated with adoption of CURE-related varieties are estimated using a random utility model and a dataset of 800 farm households. Results suggest that there has been widespread adoption of CURE-related varieties in salinity-prone areas. Further, multivariate analysis reveals that environment and location characteristics, rather than household characteristics, are the most important determinants of adoption. In particular, CURE-related varieties are more likely to be adopted in high-salinity-risk areas that are not protected by salinity barrier gates. Neighbors' adoption decisions also strongly influence household decisions to adopt CURE-related varieties. CURE-related varieties and other varieties generate similar net	https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0229464

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			revenues in a year with low salinity exposure, suggesting that CURE-related varieties are a low-cost insurance policy against salinity inundation in high-risk areas.	
S4238 - Gender differences in rice value chain participation and career preferences of rural youth in India	Completed	Other MELIA activity	This study uses a gendered approach to analyze three dimensions of rural youth in agriculture: their involvement in the rice cultivation and its value chain activities; the career preferences of male and female youth in agriculture; and the systematic differences between male and female youths in their perceptions on institutional and policy support for agriculture as a viable career choice.	https://www.tandfonline.com/doi/full/10.1080/09614524.2020.1804840
S4239 - Group contracts and sustainability: Experimental evidence from smallholder seed production	Completed	Program/project evaluation/review	This study carried out an economic experiment with real producers and organizers currently engaged in seed production to analyze their preference for group seed contracts, its sustainability and welfare implications in the seed value chain. The producers were offered two types of group contracts: Contract B involves a company-organizer-seed producer group (SPG); contract C removes the organizer and directly engages with the SPG. In the experiment, producers are asked to choose between an existing contract and either of the proposed group contracts. The experiment consists of two treatments: (i) concealed and revealed price information between agents, (ii) presence and absence of a local organizer while making the decision. Results show that the preference for group contract B is higher than for group contract C, suggesting the need for producers bargaining which can be achieved through group contract in the existing contract, Bargaining is high (6.3%) when price information is concealed.	https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0255176
S4240 - Impact of Nutrition Training on Long-Term Adoption of High-Zinc Rice: A Randomized Control Trial Study among Female Farmers in	Completed	Correlates of adoption/impact study	In Bangladesh, zinc deficiency is prevalent as stunting affects 41% of children aged under 5 years. The diffusion of high-zinc rice has been limited as seeds are largely unavailable to farmers. In Bangladesh, high-zinc rice varieties have been developed and released to address the problem of zinc deficiency, particularly among children and pregnant women. The study used randomized control experiment to examine the impact of nutrition training on the adoption of a High-Zinc Rice BRRI Dhan72. The main focus of this study	https://grispsnetwork.groupsie.com/

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Bangladesh			was to measure the long-term impact of the micronutrient training. We conducted follow-up surveys in 2018, 2019, and 2020 and found that the adoption of high-zinc rice in Aman season declined from 59% in 2018 to 7.5% in 2020 among treated farmers and from 12.9% to 1.9% among control farmers. Results indicate that nutrition training has a long-term but diminishing impact on high-zinc rice adoption.	
S4242 - Impact of Rice Trade Policy in Southeast Asia	Completed	Ex-ante, baseline and/or foresight study	This study examined the impact of rice trade policy in Indonesia and Malaysia using a global rice model based on a partial equilibrium framework. The simulation results suggest that the hypothetical rice tariffication in these two countries in 2021 would increase their imports by as much as 84.8% (Indonesia) and Malaysia (11.4%). We also find that farm prices would fall by 3.3% for Indonesia and 13.3 1% for Malaysia, while retail prices would drop by 6.2% in Indonesia. We estimate the fall in total inflation in 2021 at 0.3% for Indonesia and 0.4% for Malaysia, and less over time. The simulation results also show a slight increase in world prices, which led to small increases in the domestic prices Southeast Asian rice markets.	https://iaae.confex.com/iaae/icae31/papers/extra/index.cgi?EntryType=Paper&username=19253&password=578760
S4243 - The Future of Cereal Prices	Completed	Ex-ante, baseline and/or foresight study	Since the food price spikes of 2007-2008 and 2010-2011, there have been various efforts to predict long-term food prices. Those food price projections have mainly focused on key drivers such as population, income, agricultural productivity and climate change. This study aims to review previous cereal price projections in the long-term and provide comments on potential gaps that deserve attention. First, the potential impact of the expected reform on agricultural support policies remains to be seen when projecting cereal prices in the long-run. Second, we observe that the uncertainty impact of climate change is missing when analyzing uncertainty in future cereal prices. Third, a better understanding is needed in terms of the impact of natural disasters and pandemic on food prices coming from both supply side/logistics and demand side disruptions, in the short, medium and long term and its implications on outcomes on income growth, poverty, food security and nutrition.	https://grisnetwork.k.groupsie.com/

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S4260 - Assessment of rice threshing technology characteristics for enhanced rice sector development in Senegal	Completed	Ex-post adoption study	The study aimed to quantify farmers’ demand and assessment of the characteristics of rice threshing technologies to enhance the adoption of innovations in Senegal. Three indexes (demand, supply and attainment) of technology characteristics were estimated to assess farmers’ perceptions of the characteristics of three threshing techniques (traditional, ASI thresher and combine harvester thresher). The results showed that of the eleven selected characteristics, time savings (0.95), labour savings (0.94) and grain quality (0.93) were farmers’ key demand. The ASI thresher and combine harvester-thresher met farmers’ needs well in terms of the attributes of grain quality and production capacity. However, users of the traditional technique reported low levels of perceived usefulness, and users of the combine harvester-thresher reported low levels of ease of use. Women labour usefulness is a trade-off for advancement in threshing technologies in pursuance of rice sector improvement, implying that efforts towards developing gender-friendly threshers are required.	https://doi.org/10.1080/20421338.2021.1924424
S4261 - Assessing rice production sustainability performance indicators and their gaps in twelve sub-Saharan African countries	Completed	Ex-ante, baseline and/or foresight study	We quantified five sustainability performance indicators (grain yield, net profit, labor productivity, and nitrogen (N) and phosphorus (P) use efficiencies) to benchmark rice production systems in SSA. Data were collected in 12 countries (Benin, Cameroon, Cote d’Ivoire, Ghana, Madagascar, Mali, Niger, Nigeria, Senegal, Sierra Leone, Tanzania and Togo). The mean yield varied widely between 2.5 to 5.6 t ha ⁻¹ and 0.6 to 2.3 t ha ⁻¹ in irrigated and rainfed lowlands, respectively, with an average yield of 4.1 and 1.4 t ha ⁻¹ , respectively. Across the country-production system combinations, there were yield gaps of 29–69 %, profit gaps of 10–89 %, and labor productivity gaps reaching 71 %. All sites for rainfed lowlands were characterized by low-yield and large gaps in yield, profit, and labor productivity, whereas irrigated lowlands in some countries (Madagascar, Mali, and Togo) have similar characteristics as rainfed ones.	https://doi.org/10.1016/j.fcr.2021.108263
S4262 - Short-term impact of the COVID-19 pandemic on the livelihood of	On-going	Program/project adoption or impact	The COVID-19 pandemic is a major international health crisis which has resulted in simultaneous economic, social and food security crises. This study aimed to provide a snapshot of the short-term impact of the COVID-19 pandemic on smallholder rice farmers	https://EconPapers.repec.org/RePEc:ags:aesc21:312071

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smallholder rice farmers in developing countries		assessment	in Côte d'Ivoire. Results showed that all rice farmers were aware of coronavirus disease, and television and radio were the main sources of knowledge of the pandemic. After one growing season, the pandemic had negative impact on access to inputs, access to hired labor, yield, income and food security. Around 43% of farmers experienced at least one negative impact of the pandemic. About 30% of farmers perceived that the rice yield and income decreased due to the pandemic. Access to inputs and hired labor became more difficult and expensive for about 28% of farmers. Surprisingly, farmers in more remote villages were also affected by the pandemic as well.	
S4263 - Impact of the COVID-19 pandemic on food security and income in developing countries of stakeholders: a case study of rice value chain actors	On-going	EPIA: Ex-post Impact Assessment	This study assessed the impact of the COVID-19 pandemic on income and food security of rice value chain actors. A total of 1,330 rice value chain actors were randomly sampled in Cote d'Ivoire and Madagascar. Results showed that 90% of actors perceived that their income decreased due to the pandemic. Access to credit became difficult for 43% of actors. Access to inputs and hired labor became difficult and expensive. Quantity of parboiled and milled rice decreased for more than 87% of parboilers and millers. We found evidence that the pandemic decreased the income of rice farmers by about US\$ 169 per month. This led to a reduction of the number of meals by 0.14 unit per day and put 32% of rice farmers in food insecurity. The facilitation of credit and input access for smallholder farmers could be one strategy to avoid food shortages and deficits among value chain actors.	https://iaae.confex.com/iaae/icae31/meetingapp.cgi/Paper/19348
S4264 - Comparative Analysis of Rice Yield Determinants in Irrigated Production System in West Africa: Evidence from Classification And Regression Trees Model in Mali	On-going	Ex-ante, baseline and/or foresight study	Understanding the yield variability and its determinants is the first step to reduce the yield gap and increase production. This paper evaluated the socioeconomic and field management factors influencing rice yield variability among farmers in the dry and wet seasons. Data were collected from 2445 households in Mali and Senegal. Most rice farmers grew rice during the dry season in Senegal with the opposite in Mali. In Senegal, yields were higher in the dry season (6.3 to 6.6 t ha ⁻¹) than in the wet season (4.9 and 5.3 t ha ⁻¹). The season-to-season variation was less observed in Mali. Yield variability was determined by distance to market, rate and first application date of phosphorus and	https://iaae.confex.com/iaae/icae31/meetingapp.cgi/Paper/19240

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and Senegal.			nitrogen fertilizers, number of nitrogen fertilizer applications after sowing, size of plot, amount of seed use and the use of quality seeds. The dissemination of seasonal good agricultural practices will enhance yields in West Africa.	
S4365 - Fertilizer Expenditure and Overseas Remittances: Evidence from the Philippines	Completed	Other MELIA activity	1. The paper explores a relationship between farm household total expenditure on fertilizer and overseas remittances inflow in the Philippines. 2. It uses data from the loop surveys in the Philippines, conducted in the wet and dry season every four to five years from 1966-67 to 2015-16. 3. The main finding is that remittances recipients' families invest more in fertilizer to enhance rice productivity. 4. The households with fertilizer expenditure in the mid-range tend to leverage the benefit of remittances most.	https://grisnetwork.k.groupsite.com/
S4368 - Estimating Food Demand and Impact of Market Shocks on Food Expenditures: The Case for the Philippines	Completed	Other MELIA activity	The study uses recently released 2018 FIES data on food expenditures from the Philippines. The study uses the Stone-Lewbel price index to accomplish the objective in the absence of price data on food items. Results show that demand for rice with respect to prices and expenditure is relatively inelastic compared to other food groups. Income elasticity for rice is inelastic (0.27), slightly higher than the income elasticity of sugar. Demand for rice, in general, is less elastic for higher-income Filipinos and families residing in urban areas. Findings reveal that, in the short run, a 15% decrease in income or a 20% increase in rice prices induces families to spend more of their expenses on rice at the expense of meats, fish and other food groups. Finally, income and rice price shocks have a differential impact on low-income and high-income Filipino families.	https://grisnetwork.k.groupsite.com/
S4369 - Revisiting yield gaps and the scope for sustainable intensification for irrigated lowland rice in Southeast Asia	Completed	Other MELIA activity	☐ Rice yield gaps were decomposed into efficiency, resource, and technology yield gaps for four regions in Southeast Asia. ☐ Yield gaps were greatest in Bago (Myanmar), intermediate in Yogyakarta (Indonesia) and Nakhon Sawan (Thailand), and smallest in Can Tho (Vietnam). ☐ There is scope to intensify rice production in Bago by narrowing resource yield gaps with increased use of fertilizers. ☐ Fertilizer use must be reduced in Yogyakarta while increasing rice yields through narrowing efficiency and technology yield gaps. ☐ More efficient rice production in Nakhon Sawan and Can Tho is needed to meet	https://grisnetwork.k.groupsite.com/

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			production, economic and environmental goals	
S4371 - Helping Feed the World with Rice Innovations: RICE Research Adoption and Impact on Farmers Globally	Completed	Synthesis (secondary) study	This article reviews 20 ex-post impact assessment studies on rice varieties, agronomic practices, institutional arrangements, information and communication technologies, and post-harvest technologies used by rice farmers in the developing world from 2016 to 2021 of the CGIAR RICE agri-food program implementation. We found that stress-tolerant varieties in Asia and New Rice for Africa (NERICA) varieties in Africa had a significant impact on rice yield and income. Additionally, institutional innovations, training, and natural resource management practices, such as direct-seeded rice, rodent control, and iron-toxicity removal, have a considerable effect on smallholder rice farmers' economic well-being (income and rice yield). Given the important uptake of stress-tolerant varieties documented in Latin America, additional positive impacts are expected.	https://grisnetwork.k.groupsite.com/

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
CGIAR Research Program 2020 Reviews: Rice Agri-Food Systems (RICE). Rome: CAS Secretariat Evaluation Function. https://cas.cgiar.org/	1-9	1. RICE should continue to strengthen its work on seed systems, with a dedicated team and partnership network. Investments in this area should be at least doubled in the future. 2. To the extent feasible within the remainder of the CRP timeframe, all Centers (including non-CGIAR centers) should mobilize funds and capacities to the CRP and close the gaps between differences in research outputs (publications) and bilateral funding delivered by Centers part of the CRP. 3. RICE should analyze mechanisms for its innovations to be taken to the scaling pathways. Several strategies for doing so are recommended in the detailed recommendations. 4. RICE programming can better frame its sustainable intensification work. To the degree feasible	Complete	#1: RICE continued to strengthen its work on seed systems, and RICE staff actively contributed to the development of OneCGIAR initiatives with a seed system component. Future funding for RICE is irrelevant after 2021.#2: No new bilateral projects were mapped to RICE in its last year of operation.#3: Suggestions for analyses have been followed up and several resulting publications were produced; e.g.: https://authors.elsevier.com/c/1d-DJiZ5t5Em3 ; Flor, R.J.; Tuan, L.A.; Hung, N.V.; My Phung, N.T.; Connor, M.; Stuart, A.M.; Sander, B.O.;Wehmeyer, H.; Cao, B.T.; Tchale, H.; et al. Unpacking the Processes that Catalyzed the Adoption of Best Management Practices for Lowland Irrigated Rice in the Mekong Delta. <i>Agronomy</i> 2021, 11, 1707. https://doi.org/10.3390/agronomy11091707	RICE management team	until December 2021	Flor, R.J.; Tuan, L.A.; Hung, N.V.; My Phung, N.T.; Connor, M.; Stuart, A.M.; Sander, B.O.;Wehmeyer, H.; Cao, B.T.; Tchale, H.; et al. Unpacking the Processes that Catalyzed the Adoption of Best Management Practices for Lowland Irrigated Rice in the Mekong Delta. <i>Agronomy</i> 2021, 11, 1707. https://doi.org/10.3390/agronomy11091707 Connor, M., , H. Sustainable rice production in the Mekong River Delta: Factors influencing farmers’ adoption of the integrated technology package “One Must Do, Five Reductions” (1M5R). <i>Outlook Agric.</i> 2021, 50, 90–104; https://doi.org/10.1177/0030727020960165 Valera et al. 2021: Impact of Nutrition Training on Long-Term Adoption of High Zinc Rice: A Randomized Control Trial Study Among Female Farmers in Bangladesh.

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	<p>in the remainder of the CRP timeline, RICE should increase its research on sustainable production trade-offs. 5. An in-depth, independent review of private sector engagement in RICE for scaling up and adoption can be carried out to guide engagement models for achieving wider adoption and deeper impact. 6. ToCs at the CRP and flagship levels are, by their very nature, generic. While these are helpful, project-specific ToCs could be more granular and useful for tracking progress and identifying barriers along the ToC. 7. RICE should engage external team leaders in significant impact areas being assessed. This can provide more accountability and given CGIAR donors confidence about impacts being achieved. 8. In its 2020 annual reporting, RICE should consider capturing an extended summary of achievements and gaps related to the ToCs, at both the CRP and FP levels. 9. Improving the quality of science at the CRP would mainly require three interventions: (1) a gender-balanced ratio in staffing, (2) more open-access publications, and (3) a merger of FP4 and FP5, which would likely increase synergy and efficiency in operation.</p>	<p>onnor, M., , H. Sustainable rice production in the Mekong River Delta: Factors influencing farmers’ adoption of the integrated technology package “One Must Do, Five Reductions” (1M5R). <i>Outlook Agric.</i> 2021, 50, 90–104; https://doi.org/10.1177/0030727020960165V alera et al. 2021: Impact of Nutrition Training on Long-Term Adoption of High Zinc Rice: A Randomized Control Trial Study Among Female Farmers in Bangladesh. https://iaae.confex.com/iaae/icae31/papers/extra/index.cgi?EntryType=Paper&username=18950&password=358574Salt-tolerant rice variety adoption in the Mekong River Delta: Farmer adaptation to sea-level rise SongYi Paik,Dung Thi Phuong Le,Lien Thi Nhu,Bradford Franklin Mills; https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0229464#4: Trade-offs are being addressed in the framework of the Sustainability Indicators of the Sustainable Rice Platform, which quantifies and scores various socio-economic, biophysical, and environmental indicators. https://preferredbynature.org/library/standard/srp-performance-indicators-sustainable-rice-cultivation-version-21#5: The commissioning of such review falls outside the available time in 2021.#6: Indeed, we at individual project level (below the flagship project level), we developed separate and more granular ToCs. Reporting at such level is too detailed for the CRP annual reports, but does happen at project level (to be found in</p>		<p>https://iaae.confex.com/iaae/icae31/papers/extra/index.cgi?EntryType=Paper&username=18950&password=358574 Salt-tolerant rice variety adoption in the Mekong River Delta: Farmer adaptation to sea-level rise SongYi Paik,Dung Thi Phuong Le,Lien Thi Nhu,Bradford Franklin Mills; https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0229464 Sustainability Indicators of the Sustainable Rice Platform, which quantifies and scores various socio-economic, biophysical, and environmental indicators. https://preferredbynature.org/library/standard/srp-performance-indicators-sustainable-rice-cultivation-version-21</p>
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			<p>project proposal documents, and project review documents)#7: Actually, we 'outsource' most of our impact assessments/studies to third parties (usually universities/ARIs).#8: In annual reporting, we have to follow the templates as provided by the System Office and as implemented in MARLO#9: These are suggestions that will carry over into the new OneCGIAR structures and initiatives; it is not opportune to merge two RICE flagships in the last 10 months of the program</p>			
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Table 12: Examples of W1/2 Use in this reporting period (2021)

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) Select only one category.
Contribution to OneCGIAR change processes, such as participation in Design Working Groups, Initiative Development Teams, etc.	Other: Development of OneCGIAR Initiative proposals
Development of PyRice: a Python package for querying Oryza sativa databases	Research
Development of NOISYmputer, a new algorithm that provides high-quality datasets	Research
Development of a fast annotation process with the Table2Annotation tool	Research
Development of Herramientas de Costo de Produccion del Arroz CIAT-FLAR v3.3; Tool to compute cost of rice production.	Research
Development of a Relative maturity system for rice that is globally valid	Research
Unified (modern) rice breeding strategy across IRRI and AfricaRice	Partnerships
GWAS analysis of Aus for anaerobic germination and stagnant flooding	Research
Identification of donors for drought prone direct seeded rice	Research
Fine-mapped qSES1.2 interval, candidate genes, marker systems	Research
Further enhancement and characterization of the dry seeded rice (DSR) core panel	Research
Application of classification models in screening superior rice grain quality in male sterile and pollen parents	Research

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Expansion of the national agriculture research and extension systems (NARES) breeding network in line with the market segmentation	Partnerships
Creation of dry seeded rice (DSR) field facilities at IRRI HQ, IRRI South Asia Hub, IRRI ESA (Kenya), AfricaRice (Senegal, Ivory Coast)	Partnerships
Breeding program organization by maturity groups as early, medium, and late maturity	Other cross-cutting issues
Rice variety donors for tolerance to Fe toxicity in West-Africa among interspecific <i>O. sativa</i> x <i>O. glaberrima</i> lines of a QTL mapping population	Research
NILs in the genetic background of IR 64 and Sahel108 having introgressed the <i>actpk1</i> gene that increases ammonia uptake were evaluated under irrigated conditions. Grain yield increased by 11 to 17% in Sahel108-NILs.	Research
Completion of the development of IR 64 NILs for partial blast resistance genes; <i>pi21</i> (BC5F5), <i>Pi35</i> (BC2F5), and <i>Pb1</i> (BC6F5).	Research
2 potential upland rice varieties with 15 - 20% reduction in yield loss caused by low soil fertility in smallholder farms developed and tested in farmer's fields (so the varieties are 15% and 20% better compared to a local variety under low-input management.	Delivery
Three new rice varieties (F191, F192, F193) for the uplands in Madagascar	Delivery
Biofortified rice variety Fedearroz BioZN-035 for Colombia	Delivery
Impact of COVID 19 on rice sector: simulation of different economic slowdown and recovery scenarios	Policy
The impacts of reforming agricultural policy support on cereals prices: A CGE Modeling Approach	Policy
Gender differences in rice value chain participation and career preferences of rural youth in India	Research
Group contracts and sustainability: Experimental evidence from smallholder seed production	Research
Impact of Rice Trade Policy in Southeast Asia	Policy
Modelling the Impacts of Agricultural Policy Support on GHG Emissions in the rice sector	Research

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Sustainable Rice Platform (SRP) Standard and Performance Indicators in Africa	Partnerships
Two-row Motorized Paddy Weeder for Irrigated and Rainfed Lowland Systems in Eastern Africa	Delivery
Two-row adapted Motorized Weeder (AMW) for irrigated and rainfed lowland systems in sub-Saharan Africa	Delivery
RiceAdvice: an android-based application for rice crop management in Burkina Faso, Mali and Senegal	Delivery
RiceAdvice-WeedManager android application for Sub-Saharan Africa	Delivery
Rice management options for salinity in Senegal River Valley	Research
Good agricultural practices (GAP) to improve rice productivity in several East African countries	Delivery
Crop diversification options to improve farmers' livelihoods in Madagascar lowlands	Research

Table 13: CRP Financial Report

	2020 forecast (W1/W2)*	2021 budget (W1/W2)*	Comments on major changes*
Personnel	US\$ 5,712,157.00	US\$ 5,379,181.01	small decrease compared to 2020
Consultancy	US\$ 144,924.88	US\$ 222,421.50	small increase compared to 2020
Travel	US\$ 56,072.00	US\$ 68,876.00	small increase compared to 2020
Operational expenses	US\$ 2,989,986.34	US\$ 3,632,883.80	small increase compared to 2020
Collaborators and partnerships	US\$ 896,557.59	US\$ 1,157,996.58	small increase compared to 2020
Capital and equipment	US\$ 141,563.00	US\$ 148,641.00	small increase compared to 2020
Closeout cost	US\$.00	US\$ 60,000.00	No close out cost in 2020
CRP Total	US\$ 9,941,260.81	US\$ 10,669,999.89	small increase compared to 2020

Annexes

Table Annexes

FP	Detailed Annex
F1: Accelerating impact and equity	
F2: Upgrading rice value chains	
F3: Sustainable farming systems	<p>IRRI Farming systems analysis (FP3.1) Assessing challenges to scaling of AWD (Philippines) and Improved water management practices (India, Philippines, Indonesia) Intensification mechanization (FP3.2) 1. CORIGAP: 783.529 households in 6 countries increased yield: Indonesia (13-90%), China (11%), Myanmar (13%), Sri Lanka (4-20%), Thailand (1%) and Vietnam (8%) and profits from rice farming Indonesia (17-90%), China (21%), Myanmar (30%), Thailand (15%) and Vietnam (28%) 2. Integrated crop management including mechanization options and IPM were disseminated and increased rice yield in Bangladesh, Cambodia, India, Vietnam. 3. Scientific evidence and promotion of mechanized transplanting/direct seeding in Vietnam contributed to reduced seed rate by 40-60%, pesticide use by 40-50%, and nitrogen use by 20-30%. 4. Scientific evidence and promotion of mechanized direct seeding (new APV-precise seeder) in Vietnam helped reduce seed rate by 40-60% and nitrogen use by 20-30%. 5. Laser leveling introduced in Thailand and the Philippines and scaled out through cooperation with the private sector. Farm diversification (FP3.3) 1. Ecological Engineering (EE) using farmer’s preferred vegetable crops on the bunds, enables diversified landscape and pest management benefits in Cambodia. 2. Options to diversify rice during wet-season identified and evidence of benefits documented in India. 3. Diversified crops including sunflower, maize introduced and disseminated in rice-based system in Bangladesh. 4.</p>

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Hybrid rice was promoted to improve rice yields and to bring wheat sowing time on time in rice-wheat systems in India

AfricaRice. In Rwanda, country-specific good agricultural practices (GAPs) were developed. Large scale GAP demonstration plots were established and 2,000 rice farmers were trained through farmer field days. Promising crop and nutrient management practices were identified in Ethiopia, Uganda, Tanzania, and Madagascar. In Ethiopia, transplanting instead of direct seeding increased the yield by 18 to 23% (yield increased from 3.8 to 4.4 t/ha) by avoiding the terminal cold induced sterility. P micro-dose placement increased the rooting depth of upland rice that can be beneficial to avoid drought stress in Tanzania and Madagascar. Micro-dose P placement enhanced the deep root section by 22 to 33% with an enhanced P recovery rates (13 to 58%, i.e. 4- to 5-fold) and fertilizer use efficiency (110 to 458 g biomass per g P applied; i.e. 9- to 14-fold) compared to broadcast P. A yield increase of 1 to 1.8 t/ha was observed for micronutrient application under irrigated lowland and rainfed lowland conditions under moisture stress free conditions in Tanzania. Crop diversification options were jointly tested with farmers in Cote d'Ivoire, Madagascar, Senegal, and promising options were identified together with farmers. In Madagascar, 4 to 5 spp. out of 12 spp. produced considerable yield which is equivalent to a rice yield of 0.5 to 5 t/ha during off-season which is about 13% to 125% increase in farm income per year depending on the vegetable spp. compared to rice cultivation alone. In Ivory Coast, the agronomic and economic performances of different off-season crops were assessed from 2019 to 2021 in two lowlands. The off-season crops were tomato, okra, cucumber, zucchini, and green bean. The highest agronomic (yield) and economic (net income) performances were obtained with cucumber and tomato. Agronomic performance and farmers' preference of vegetables and legumes were evaluated in irrigated rice-based farming systems in Senegal. Based on farmers' preference (crop duration and productivity) and agronomic performance in two seasons, 8 promising crops with rice equivalent yield of 12 to 125 t/ha were selected and are currently testing in 30 farmers' fields. Economic analysis showed that rice-tomato and rice-onion rotational systems can increase profit by USD 1211 (97%) and USD 4431 (345%), respectively in comparison with rice-rice systems.

CIAT/FLAR and local partners in Uruguay had 15 demonstration plots on good agronomic practices across all growing regions in this country. We found a 20% yield increase in demonstration plots (10,560 Kg/ha), under improved practices (mainly less seed per area unit, fertilization based on soil analysis, and irrigation management), as compared to the conventional management (9,165 kg/ha).

CIRAD. Data from 4-year experiment comparing different legumes schemes integration of rice bi-annual rotations in Madagascar were analyzed and published. Modelling study showed that green manure improve rice performance, but specific attention has to be paid to the N leaching. A 2-year participatory experiment focusing on trade-offs between social, environmental and economic

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	<p>services showed that upland rice in rotation with sole legume cropping with traditional pulses could be the best options in low input cropping systems.</p> <p>JIRCAS. Field experiments identified that the <i>Stylosanthes guianensis</i> can be a promising cover/relay crop to integrate into the upland rice-based production system in central highlands of Madagascar with high P acquisition capacity from P-deficient soils and improvement of the subsequent upland rice yield. JIRCAS developed and published the user manual for researchers and agricultural extension workers to facilitate climate-smart agriculture in rainfed rice production on their own and at any places.</p>
<p>F4: Global Rice Array</p>	<p>AMMI analyses of the AP data identified 8 clusters sites with climate and or disease constraints and germplasm was used as sensor of the environment. For example, Giza 178 (a heat tolerant variety) was the best performer in Group 1 with low radiation, high night temperature, and no disease. Also we observed a lack of tolerance to abiotic stress in high yielding varieties, all the high yielding varieties clustered together in Group 7 with high yielding environments but showed the largest yield decrease (50%) across environments. This suggested that high yielding varieties doesn't have the tolerance to different biotic/abiotic stresses hence breeders should introduce this resistance as a climate change adaptation strategy. UAV collaboration on the global rice array was extended to partners at the Taiwan Agricultural Research Institute. An implementation of the Breedbase (Imagebreed) database was adopted for UAV image and analysis and data. New surveys of pathogen diversity were undertaken for sheath blight and brown spot, and metagenome methods were applied to detect novel viruses in a survey from Burkina Faso. An updated project website was developed for Flagship results: https://sites.google.com/irri.org/globalricearray/home. Training on tools for GWAS analyses was accomplished in two courses, introductory and advanced SNPs to GWAS, for 45 trainees from NARES, National Universities, and advanced research institutes,</p>
<p>F5: New rice varieties</p>	<p>FP5.1 Use of genetic diversity continued to prove useful to identify novel donors and genes for traits of interest in breeding. New information was published on grain arsenic, cadmium uptake, nitrogen deficiency, reproductive stage salt tolerance among other traits. Further studies were published regarding grain Zn and Fe, anaerobic germination, drought, and blast. These studies provide evidence for their future (or ongoing) uptake by breeders. FP 5.2 Deployment of many genes has progressed, and several new genes brought to completion, including new genes for RYMV and BPH resistance. Phenotypic evaluation of completed products has commenced. Seed has been distributed to IRRI breeding programs, as well as partners in Bangladesh and Africa. FP5.3 In line with the expectations on creating market demanded varieties and rapid varietal turn-around, leading to increased genetic gains, IRRI's breeding programs through OneRice have adopted an end-to-end framework. The current breeding programs have a shorter breeding cycle, centralized pre-breeding, improved breeding and on-farm trialing network, and a close interaction with NARES</p>

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partners.FP5.4 has been one of the most active CoAs in the area of climate change. The activities targeted through this CoA have laid the foundation for high quality rice breeding to address challenges related to climate change in the years to come. In particular, the establishment of a dedicated DSR breeding program, market segmentation, and product concepts are critical for rice breeding effort in the years to come.FP5.5 To define the cooking and eating quality (CEQ), the pasting properties in combination with starch properties were used to develop two layered models in order to classify the rice varieties into twelve distinct CEQ ideotypes with unique sensory profiles. We conducted random forest modeling using 1.8 million high density SNPs and identified top 1000 SNP features which explained CEQ model classification with the accuracy of 0.81.Results of this study have shown that the RVA properties and starch structure properties can be utilized to distinguish 12 CEQ ideotypes with different sensory textural profiles. These models can be used as a detailed selection tool for screening of a variety that can be included as selection criteria in the breeding programs to cater the needs of both farmers and consumers. To breed low glycemic index (GI) rice varieties, we have defined the genetics and identified two IRRI breeding lines IRRI 162 and IRRI 163 with GI of 55 and 57, respectively, with yield of 6.40 tons/ha and 6.9 tons/ha. In addition, advanced RILs with elevated amylose (more than 30%) with low GI (median of 38) exhibit good yield potential was developed.FP5.6 optimized the on-farm trials in NARES reducing the number of trials and better allocating the trials, developed a new way/method to analyze on-farm trial data, worked on the unification of breeding analytics pipeline, and -based on simulations- developed new breeding schemes and index of selection.JIRCASFP5.1 (2021) Selected donors for tolerance to Fe toxicity in West-Africa among interspecific *O. sativa* x *O. glaberrima* lines of a QTL mapping population. Donors have been shared with counterparts in Madagascar for confirmation of tolerance and initiation of a breeding populations in crosses with local varieties.FP5.2 (2021) Developed Genomic Selection models for the 3K SNP-Seek set for 1) grain Zn concentrations and 2) yield under low-fertility conditions in Madagascar and showed that a GP approach is suitable for identifying new donors. As a result five donors have been utilized in the development of new breeding populations (2021).FP5.3 (2021) 1) Completion of the development of IR 64 NILs for partial blast resistance genes; pi21(BC5F5), Pi35(BC2F5), and Pb1(BC6F5). 2) NILs in the genetic background of IR 64 and Sahel108 having introgressed the actpk1 gene that increases ammonia uptake were evaluated under irrigated conditions. Grain yield increased by 11 to 17% in Sahel108-NILs. FP5.4 (2021) (1) 2 potential upland rice varieties with 15 - 20% reduction in yield loss caused by low soil fertility in smallholder farms developed and tested in farmer's fields (so the varieties are 15% and 20% better compared to a local variety under low-input management. Variety release proceedings are ongoing together with Malagasy counterpart organization FOFIFA but are delayed due to COVID-lockdown during the crucial reproductive stage inspection period. (2) We also developed 2 new lowland varieties and these shall be released officially on Nov 4.

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.
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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 (CO₂) equivalent/year by 2022 and by a further 28.4 megatons CO₂ 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



**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.

