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

2019 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

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

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2019 CRP Annual Reporting

RICE

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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, CIRAD, IRD, IRRI, JIRCAS

EXECUTIVE SUMMARY

Details and supporting evidence are found at the GRiSP.NET share site.

The Impact Assessment of the International Rice Genebank (IRG) on Improved Rice Varieties in Eastern India revealed that 45–77% of the genetic composition of improved rice varieties comes from the genes of IRG accessions (Villanueva et al. 2019). A 10% increase in the genetic contribution of IRG accession on an improved rice variety increases the yield by 27%.

The Coalition for African Rice Development (CARD) was established in 2008 with the goal of supporting efforts of African countries to double rice production by 2018. Arouna (2019) assessed the impact of CARD and its supported activities, and showed that over the period 2008-2018, rice production, harvested area and yield increased by 103%, 60% and 27%, respectively (in absolute numbers: additional 6.15 million ton of paddy rice, 1.65 million ha of additional area and 0.29 t/ha of yield increase).

Progress on enhanced smallholder market access and increased value capture by producers was made through market analysis for (i) targeted product profiling; (ii) sustainable rice value chain upgrading; (iii) commoditization of traditional rice and by-products; (iv) sensory quality and hedonic pricing of grain quality; and (v) impact assessment of marketing strategies.

Contributions to increased income and employment and diversified enterprise opportunities include (i) postharvest innovations in Asia; (ii) publications on rice straw; (iii) standardization of processing technologies with private sector in Africa; (iv) pilot of pop-rice equipment with rice husk furnace in Africa; and (v) research on rice products. Progress on increased productivity and reduced pre- and postharvest losses was achieved through (i) verification of the GrainSafe Dryer with NARES and private partners in Asia; (ii) Goronyo rice innovation platform in Africa; and (iii) prototypes for rice husk fueled flat-bed dryers in Africa.

Arouna (2019) assessed the impact of RiceAdvice, using randomized control trial in Nigeria. Results show that treated households increase yields by 549 kg/ha compared to their matched control households (an increase of 15%). Treated households increase their income by about $227 (i.e., 20% over control households). In 2019, a total of 19,756 farmers of which 2043 women received RiceAdvice recommendations and guidelines to cover 12,796 ha in Nigeria, Burkina Faso, Mali, Senegal.

Screening and validation experiments using germplasm panels and populations resulted in the discovery of novel donors and genomic regions associated with anaerobic germination, stagnant flooding, grain zinc content, sheath blight tolerance, and drought/direct seeded rice. RICE continued to produce high yielding breeding material and releases across target geographies in favorable, irrigated systems globally. Thousands of new breeding lines were generated and hundreds of more advanced lines were tested and advanced towards variety release. Mainstreaming high zinc content in irrigated breeding targets was initiated.

312 peer-reviewed papers were published (59% open access). Three publications in Science and Nature Biotechnology journals had Altmetric scores of 36-41.

467 scholars (48% female) were enrolled in long-term degree programs. Around 53,000 people (33% female) participated in short-term training courses and capacity-development events. Full details are provided at: http://www.grisp.net/file_cabinet/folders/277692.

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)

Paik et al., 2020 examined the diffusion of salt-tolerant rice varieties (STRVs) promoted in the Mekong River Delta through the Consortium for Unfavorable Rice Environment (CURE) and found evidence of widespread adoption in salinity-prone areas, with CURE promoted-varieties covering 47% of rice area. The CURE program has effectively targeted unfavorable rice growing areas in Vietnam, and CURE

promoted-varieties have increased profits in salinity vulnerable areas and generate approximately 19 million USD in value added for the 2017/18 Dong Xuan season.

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Saito et al., 2019 conducted a multidisciplinary evaluation of lowland rice variety WITA 9 which is resistant to Rice yellow mottle virus (RYMV). Results showed that WITA 9 has a yield advantage of 0.7 t ha–1, and its adoption increased farmer's income by US$ 91 ha–1 per season, thereby contributing to food security.

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

1.2.1 Overall CRP progress (max 1000 words)

The Impact Assessment of the International Rice Genebank (IRG) on Improved Rice Varieties in Eastern India revealed that 45–77% of the genetic composition of improved rice varieties comes from the genes of IRG accessions (Villanueva et al. 2019). A 10% increase in the genetic contribution of IRG accession on an improved rice variety increases the yield by 27%.

The Coalition for African Rice Development (CARD) was established with the goal of supporting efforts of African countries to meet rice self-sufficiency by 2030. Arouna (2019) assessed the impact of CARD and showed that over the period 2008-2018, rice production, harvested area and yield increased by 103%,

60% and 27%, respectively. CARD has an annual impact of 6.15 million ton of paddy rice, 1.65 million ha of additional area and 0.29 t/ha of yield increase.

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1.2.2 Progress by flagships

F1 - Flagship progress:

New collaborative studies were initiated with IFPRI, FAO, OECD and the University Arkansas on foresight. The IRRI Global Rice Model was updated and upgraded. A baseline was developed, calibrated, and projections were formulated on the global rice market. Simulation on the rice tariffication policy in the Philippines was performed to underpin early policy dialogue with the Department of Finance and Rice Traders.

Seed and variety dissemination roadmaps were developed for a number of countries: Burkina Faso, Gambia, Guinea, Mali, Nigeria, Sierra Leone, Ethiopia, Uganda and Madagascar.

New approaches for policy engagement were tested and piloted in three countries (Papua New Guinea, Philippines, and Indonesia) with the ambition to show the usefulness of using policy oriented research outputs in policy processes to increase the influence of IRRI in policy circles.

A workshop was organized in May 2019, in Rome to build a community of practice around cutting-edge methodologies on monitoring, evaluation, as well as ex-post and ex-ante impact assessment. IRRI, AfricaRice and CIAT responded proactively to the calls for impact assessment studies initiated by SPIA and successfully secured a grant.

A monitoring, evaluation and learning workshop was organized to facilitate scientists' understanding and knowledge in using MARLO reporting and planning platform.

Detailed Annex:

- In India, women-headed households, Scheduled Tribe and Scheduled caste exhibit higher adoption rates for STRVs. Engagement of women as seed producers catalyses adoption. Women users prefer seed from women producers due to easier access and trust in quality.
- Bacud et al (2019), found that in Vietnam, migration contributes to increased off-farm income, with higher income from international migration. While men's labour contribution declines in migrant

households, women's labour increases in the majority of production stages.
- In Vietnam, Bacud et al (2019), found that there is a negative association between increased women's work burden and rice yield. Farm inputs and hiring labour contribute to higher yield, but remittances are not generally used for this purpose.
- Zossou et al. (2019) analyzed factors influencing farmers in acquiring agricultural knowledge and adopting technologies in 5 African countries. Gender gap was observed in Côte d'Ivoire and Niger on knowledge about agricultural technologies and use of improved farming methods.
- The adoption of "smart-valley approach" increased yield by 0.9 t/ha and income by 267 US$/ha in Benin (Arouna and Akpa, 2019). The impact is greater for men than for women (0.95 tons/ha for men and 0.88 tons/ha for women).
- The adoption of Smart-Valley technology in Togo showed that despite the participation of female farmers in trainings on the technology, the implementation by women was limited by the required physical effort and labour (Arouna and Akpa, 2019).
- Arouna and Akpa (2019) noticed that women's role in Smart-Valley adoption remains relegated to less labour-demanding, less rewarding activities (e.g. fetching water, preparing meals). Adoption will be improved if emphasis is on group learning and collective action.
- Promoting salt-tolerant rice varieties in lowland ecologies allows recouping rice production in salt-affected areas, retaining rice-farming communities' source of livelihood and maintaining the essence of the role of women as a food providers in households (Senegal).
- Women groups serve as channels for empowering women by providing labour and participating in income generating activities. Women associations serve as channels to access knowledge and skills for seed production, and to have access to land for farming (Madagascar).
- Understanding trait preferences to contribute to gender responsive breeding priorities, studies reveal that yield remains a key needed attribute for male and female farmers. Value added traits such as grain quality and stickiness are also important to farmers (Madagascar).
- Women's entry into profitable businesses is limited mainly by the lack of awareness, skills, capital, basic business tools and the perception on gender-specific nature of some farming activities (Nigeria).
- The SWOT analysis on promoting women and youth entrepreneurship in Madagascar revealed that while access to finance remains a key challenge, allocating land to female groups and the promotion of co-financing and self-help contributions help alleviate the financial constraint.
- A Youth strategy has been developed and is under review for publication. The strategy is built on a resilience framework and is designed with a goal of engaging youth to contribute to and benefit from sustainable rice agri-food systems.
- A workshop was conducted to share the review in the Youth strategy. The review threw out very interesting issues and trying to frame both the review and strategy in the context of climate change worked well.
- The workshop involving young people to capture their voices, perceptions, aspirations, choices and needs was very effective and gave a new flavor to the thinking. This also highlighted potential partners to work in this area to implement the strategy.
- To promote youth employment in the rice value chain within the PEJERIZ project (funded by CTA-EU/ACP), 103 youth business plans were developed (52 business plans for Senegal and 51 for Mali representing 38% female and 62% male).

- Training on the use of ICT and social media for agribusiness were organized for 204 youth agripreneurs (104 in Mali and 100 in Senegal, representing 32% female and 68% male) to enhance their entrepreneurial skills.
- Before the ICT training, 3 to 13 % had experience in the use of ICT and social media in agribusiness. After the training, more than 70 % of youth are willing to use the tools for networking and communication.
- Training was organized on rice seed production technologies for 32 youth in Nigeria and Benin Republic) to enhance their skills and provide them employment opportunities in the agricultural sector.
- 120 youth seed entrepreneurs trained by AfricaRice in Ibadan between 2016 and 2018 have engaged other youths in the seed production businesses in Nigeria. Tangible achievements include selling seeds to off-takers (Reza Agro Services in Akwa Ibom State).
- Analysis of rice production systems in Senegal and Mali showed no significant difference in yield and profitability between youths and adults. The rainy season in Mali and the dry season in Senegal have higher yield and are more profitable.

F2 - Flagship progress:

Progress on enhanced smallholder market access (IDO) and increased value capture by producers (sub-IDO) was made through market analysis for (i) targeted product profiling; (ii) sustainable rice value chain upgrading; (iii) commoditization of traditional rice and by-products; (iv) sensory quality and hedonic pricing of grain quality; and (v) impact assessment of marketing strategies.

Improved access to financial and other services (sub-IDO) was fostered through (i) policy papers on contract farming in Asia and West Africa; (ii) organization of AGRITECHNICA ASIA; (iii) technology transfer to local manufacturers; (iv) facilitation of equipment supply chains; and (v) establishment of six multi-stakeholder platforms in Africa.

Contributions to increased income and employment (IDO) and diversified enterprise opportunities (sub-IDO) include (i) postharvest innovations in Asia; (ii) publications on rice straw; (iii) standardization of processing technologies with private sector in Africa; (iv) pilot of pop-rice equipment with rice husk furnace in Africa; and (v) research on rice products. Progress on increased productivity (IDO) and reduced pre- and postharvest losses (sub-IDO) was achieved through (i) verification of the GrainSafe Dryer with NARES and private partners in Asia; (ii) Goronyo rice innovation platform in Africa; and (iii) prototypes for rice husk fueled flat-bed dryers in Africa.

Detailed Annex:

- FP2 has further expanded its research and training portfolio on market analysis for gender-responsive product profiling in 2019.
- Consumer demand for rice fragrance in South and Southeast Asia is found to be mainly driven by women. These insights can assist rice breeding programs in developing gender-responsive product

profiles (Bairagi et al., in press, British Food Journal).
- Demand for heritage rice produced by indigenous communities is found to be mainly driven by women. This can inform cultural heritage preservation strategies based on the commoditization of heirloom rice (Bairagi et al., under review, Agriculture and Human Values).
- A novel indicator for women empowerment was developed. Women were found to be more empowered if they were engaged in off-farm employment, which argues for increasing gender inclusiveness of rice value chain upgrading (Maligalig et al., 2019, Journal of Rural Studies).
- Indicators elicited through gamification experiments are found to be an efficient way for measuring empowerment. FP2 will facilitate spillover of this method to food choice research (e.g., Demont et al., 2019, Geography You).
- A qualitative study conducted in five communes in Benin found that the GEM parboiler lifts more women out of poverty than men.
- In Casamance (Senegal), rainfed rice cultivation is found to be predominantly a female activity. Women have limited access to motorization and inputs, though. Food security can be enhanced by increasing women's labor productivity through improved access to production factors.
- FP2 has conducted a study on preserving cultural heritage of indigenous rice communities in the northern Philippines through commoditization of heirloom rice. Results indicate a potential market size of PHP 15.7 billion (USD 344 million) that could be created for heirloom rice and tapped into by heritage farmers (Bairagi et al., under review, Agriculture and Human Values).
- FP2 published a policy article on inclusiveness of contract farming in Vietnam. The findings highlight the role policies encouraging horizontal and vertical coordination can play in fostering inclusiveness in rice value chain upgrading (Ba et al., 2019, Land Use Policy).
- The curriculum development for Agricultural Engineering (BSC) and Agricultural Machinery Mechanics done in In CoA 2.2 in Cambodia resulted in around 20 graduates of each course leaving entering the agricultural job markets in Cambodia each year.
- In 2019, FP2 engaged 65,000 smallholder farmers, parboilers and marketers in GEM parboiling related activities in five African countries (Benin, Cote d'Ivoire, Niger, Nigeria, Togo). More women and youth are now involved in rice processing following the installment of GEM parboiled rice processing facilities in several sites across Africa. The GEM rice processing facilities provide poor farmers who are vulnerable to paddy collectors the option to add value to their rice before selling.
- A study on the rice value chain in Côte d'Ivoire has identified drivers of farmer inclusion in contract farming and the drivers of improved seed adoption.
- FP2's research on sustainable rice value chain upgrading generated a major policy publication on inclusiveness of contract farming (Ba et al., 2019, Land Use Policy), which can be used as an entry point for internalizing sustainable production standards and mitigating climate change in rice value chains.
- FP2 developed a draft policy brief with strategies for becoming a global leader by institutionalizing sustainable rice production guidelines in Vietnam, which can be considered as a first step in mitigating climate change in the rice sector with important spillover potential to other countries.
- Almost all postharvest practices developed under FP2 are related to climate change, optimizing operations leads to reduced energy consumption and this less emissions and reducing postharvest losses also reduces emissions created by manufacturing and applying the inputs used for growing and processing the lost grains. We have conducted Live Cycle Assessments comparing various operations and

technologies (e.g. drying systems, different rice straw management options, etc.) which resulted in science based evidence about environmental sustainability of those options. The output of this work has been used in formulating the postharvest indicators for the Sustainable Rice Platform (SRP) and policy workshops have been conducted in Vietnam, Cambodia and the Philippines using this data.
- FP2 research in Africa has demonstrated that substituting wood for rice husk as fuel for parboiling (Mini-GEM parboiling) saves costs linked to wood purchase, reduces deforestation and greenhouse gas emissions. Utilization of rice husk furnaces is further found to reduce CO2 emissions.

F3 - Flagship progress:

Sustainable Rice Platform Standard and Performance Indicators version 2 were released in January 2019. 1,000 farmers' rice cultivation practices were assessed using these tools in Burkina Faso, Ghana, Nigeria, Senegal, and Tanzania. Through the assessments, key intervention areas for improving farmers' management practices were identified and used for developing training materials.

Introduction of labor-saving technologies together with 1 Must do and 5 Reductions (1M5R) in "Small farmers, large field" in Vietnam reduced seed rate by 45 kg/ha and pesticide use by 50%, and increase rice yield by 10%, resulting in an increase in farmer income by 20-30%. In Nigeria, working report on randomized control trial showed that use of RiceAdvice had 15 % higher yields and 20 % higher profits.

Up to end of 2019, best management practices introduced by CORIGAP in Vietnam reached 250,000 farmers. In 2019, AfricaRice and its partners disseminated innovations such as RiceAdvice and good agricultural practices to 35,000 farmers in Burkina Faso, Madagascar, Mali, Nigeria, Senegal, and Uganda.

Detailed Annex:

IRRI: Laser land leveling established in Cambodia and Vietnam (Innovation #612): in Vietnam and Cambodia, the technology has been extensively demonstrated and services are provided by government institutions, but private sector contract service provision is not yet established. Laser land leveling in Indonesia, Philippines, Myanmar, Sri Lanka (Innovation #613): in Thailand we provided support to CropTech Asia, national distributor of laser leveling equipment and inputs to the NAMA project of the Rice Department, that aims as scaling out business models and loans for laser leveling and other climate smart technologies. We conducted a multi stakeholder Laser Leveling round table discussion with the different stakeholders on December 2 in Bangkok during the AGRIFUTURE conference to discuss roles for the dissemination. For Myanmar we facilitated with TRIMBLE Australia, CropTech Asia Thailand and Pioneer Agribiz Myanmar the establishment of the supply chain for laser leveling equipment. Four sets of equipment were purchased in 2019 for large scale demonstrations through national projects.

AfricaRice: Through technologies for African Agricultural Transformation (TAAT), rice component in "Putting Research into Use for Nutrition, Sustainable Agriculture and Resilience (PRUNSAR)" program",

and RICE CRP FP3, we disseminated innovations such as RiceAdvice and good agricultural practices to 35,000 farmers in Burkina Faso, Madagascar, Mali, Nigeria, Senegal, and Uganda. Working report on Randomized control trial in northern Nigeria showed that use of RiceAdvice had 15 % higher yields and 20 % higher profits. 1,000 farmers' rice cultivation practices were assessed using Sustainable Rice Platform Standard and Performance Indicators in Burkina Faso, Ghana, Nigeria, Senegal, and Tanzania. Diversification options were jointly tested with farmers in Cote d'Ivoire, Madagascar, and Senegal.

CIRAD: In Madagascar, together with scaling partner - GSDM (Groupement du Semis-Direct à Madagascar), CIRAD organized field days which around 300 farmers were invited to. During these days, a concept of multiple-purpose services in diversifying upland rice-based cropping systems, i.e. protein supply for human and livestock as well as market (pulses), pest control, nutrient supply to soils, and rice productivity enhancement were introduced to those farmers. The next step is that based on data from field experiments and feedback from those farmers, technology dissemination tool (brochure, leaflet) will be developed in the Malagasy language, and will be disseminated. In Cambodia, testing of diversification options in lowland rice-based systems by introduction of legume crops as rotational crop were initiated and involved farmers and service providers for cropping system designing.

JIRCAS: A partner JIRCAS project identified that P-deficiency as ascribed from both low total phosphorus contents and dominance of insoluble P forms in soils is a major constraint for rice production in the central highlands of Madagascar and that the amounts of oxalate-extractable phosphorus in soils can be an appropriate index to evaluate P deficiency status of rice fields. In addition, JIRCAS developed a rapid estimation technique of oxalate-extractable P in soils using visible and near-infrared diffused reflectance spectroscopy with partial least squares regression. Under such an edaphic constraint, JIRCAS indicated that the introduction of *Stylosanthes guianensis* in the farming system could be one potential measure to improve nutrient use efficiency and crop production. *Stylosanthes guianensis* was shown to have superior solubilizing capacity of Fe-bound P in soils in pot experiment and superior P uptakes by 10- to 26- fold relative to the other major crops (rice, maize, and soybean) in field experiment. Another field experiment has been conducted to assess the positive impact of *Stylosanthes guianensis* on the succeeding upland rice yield and P uptakes. According to the field survey for 2 sites in the central highlands of Madagascar, a sowing window of rainfed rice farmers was for 1-2 months and grain yields showed a negative correlation with sowing timings which indicated sowing timing as a crucial factor to improve productivity and fertilizer use efficiency of upland rice.

FLAR (The Latin American Fund for Irrigated Rice (FLAR, by its acronym in Spanish): In Brazil, we completed the third year of work on the Project 10 plus, in partnership with the Rio Grande Do Sul State Rice Institute (IRGA, by its acronym in Portuguese). In the 2018-2019 harvest season, 2,684 producers and technicians (15.5% women) participated in field activities across the state. In total, 118 demonstration plots were cropped, covering an area of 3,790 hectares. The proposed improved management obtained an average of 9,400 kg ha-1, 12% higher than the conventional management in side-by-side commercial lots. In a three-year average, rice yields were 19% higher than the conventional management with a reduction of 25% in production cost. The results of the project and the wide adoption of the technologies throughout the state, in approximately 1.1 million hectares of rice,

demonstrate how improved agronomy and technology transfer in alliance with national organizations were able to effectively increase yields and reduce production costs, contributing in this way to the sustainability of rice in southern Brazil.

F4 - Flagship progress:

CoA 4.1.
- Global Rice Array phenotyping network established with 28 Antennae panel (AP) and 13 Reference panel (RP) sites: IRRI conducted/coordinated: 6 AP, 3 RP / 12AP, 4RP; AfricaRice: 2 AP, 2 RP; CIRAD: 4 AP, 1 RP; CIAT: 4 AP, 3 RP.
- Received and curated 48 datasets from 27 sites including soil/climate data.
- RP planted at two Madagascar sites, 2018/19 phenotyping data available for one (CIRAD).

CoA 4.2.
- Drone-based high-throughput phenotyping (HTP) conducted for AP in Philippines, India, Colombia, and Cote d'Ivoire.
- Image processing and HTP+manual data collated at IRRI and CIAT.
- Drone and satellite image analyses platform for phenotyping developed by CIAT.
- Drone-based HTP working at AfricaRice.

CoA 4.3.
- Launched a decision support system (Pathotracer; http://webapps.irri.org/pathotracer/) to monitor pathogens for breeding strategies.
- Identified 14 blast strains as most aggressive on current commercial varieties.
- AfricaRice, IRD, and NARES partners developed bacterial pathogen detection kit with LMI Patho-Bios in Burkina-Faso.

CoA 4.4 and 4.5.
- Curated AP and RP phenotypic and genotypic data.
- Site data corrected for spatial effects using experimental design.
- G x E imputation implemented and GWAS tools deployed in Rice Galaxy.

Detailed Annex:

CIRAD conducted experiments with RP in Madagascar at two different sites above sea level (asl). First, Ivory at 950 m asl and second Antsirabe at 1650 m asl. For CIAT the details of the Phenotyping platform are available at the online presentation: https://www.youtube.com/watch?v=hnq_ydC1-rwfeature=emb_logoanalyze. In the case of IRRI, the introgression lines were advanced for BPH resistance derived from *O. longistaminata, O. rufipogon, O. punctata, O. rhizomatis, O. australiensisand O. granulate*. InDel markers were identified for discriminating O. sativa and other wild species of the AA-

genome composition. For Phytobiomes, the 3000 rice genome metadata was used to identify genomic regions that affect community assembly.

For AfricaRice the project wise description is as follows:

CoA 4.1: Worldwide field laboratory

AP evaluated under irrigated conditions in Senegal (Sahel Climate Zone) and Cote d'Ivoire (Humid Forest Climate Zone). Six trials completed at these two sites revealed high-yielding, short-duration genotypes of interest. Location-specific performance was noted, probably due to temperature variation between the trial sites. In Senegal, cold stress can occur at the reproductive stage during wet season (in case of late planting) and at plant emergence during the dry season (in case of early planting). Varieties showing high yield were not consistent among the three trials in Senegal—IRGC 79837-1 had highest yield in the dry season and BR28, Supa and IRRI 104 did in the wet season. In Cote d'Ivoire, NSIC Rc240, Giza 178, IRGC 79837-1 and UPL RI 7 consistently showed high yields in the three trials.

CoA 4.2: Global phenotyping

RP evaluated under irrigated conditions in Senegal and Cote d'Ivoire. Significant GxE variation was noted. In Coted d'Ivoire several lines outperformed the local check WITA9 while in Senegal, the local check Sahel 108 was among the best. Potential sources of tolerance to salinity were also observed. Plant phenotyping capacities were upgraded in Cote d'Ivoire and Senegal by rehabilitating field sites for the evaluation of Fe-toxicity and salinity. A drone-based phenotyping platform (fixed wing eBee-Plus drone with S.O.D.A RGB and SEQUOIA Multispectral cameras) was established and used to monitor trials in Bouake (Cote d'Ivoire). Additional quadcopter drones, e.g. DJI Matrice 200 V2 with XenMuse X5s sensor and DJI Phantom 4 Pro with built-in 5 bands Multispectral sensor, and tow Emlid Reach RS+ GPS survey kits are being acquired for Bouake (Cote d'Ivoire) and Saint Louis (Senegal), respectively, as well as hardware equipment for image-data storage, processing and analysis at AfricaRice.

CoA 4.3: Genetics of rice plant interactions with the biotic environment

In collaboration with IRD and NARES at LMI Patho-Bios in Burkina-Faso, a new diagnostic multiplex PCR assay was refined using AfricaRice's strains collection. This assay was designed by the LMI Patho-Bios to potentially discriminate multiple pathogens including *Xanthomonas oryzae pv. oryzae* and *pv. oryzicola, Pantoea sp., Sphingomonas sp., Burkholderiasp*. and *Pseudomonas fuscovaginae*. Selected accessions in the antenna panels grown in M'be, Bouake, Cote d'Ivoire, were scored for resistance to major diseases (bacterial blights, Rice Yellow Mottle Virus (RYMV) and blast). Potential sources of resistance will be confirmed before being recommended to breeders. Several trials were conducted in M'be to monitor diseases incidence and changes in the pathogen population over the years and to identify accessions/genes that hold durable resistance. Available data being analyzed:
- Blast: Three-year data generated using a set of 81 differential lines in the background of LTH or CO39 as

well as in improved lines and traditional accessions/varieties.
- Rice Yellow mottle virus (RYMV): Multi-season data of six varieties harboring known resistance genes/alleles - IR64 (rymv 1-1), Gigante (Rymv1-2), Tog 5681 (rymv 1-3), Tog5307 (rymv 3), Tog 5674 (rymv1.5), Tog 5672 (rymv 1-4, rymv 2 rymv 3) as well as Bouake 189 and BG90-1.
- Rice Stripe Necrosis Virus: Based on previous research activities, a set of 6 varieties known to be susceptible or resistant to the disease were considered: susceptible (Oryzica 3 and Faro 44 (SIPI 1692033)), resistant (MG 12 and NERICA 18) and moderately susceptible (Sahel 108 and Sahel 134).
- Pantoea blights: Accessions known to be susceptible or resistant were tested at M'be and include Adny 11, Azucena, C101 A 51, Gigante, IR24, Moroberekan, NIL 130, PNA 647 F4-56 and Sahel 201.
- Bacterial leaf blight (*Xanthomonas oryzae pv. oryzae*): A set of 22 entries including 20 IRBB differential lines harboring known resistance genes (IRBB1-8, IRBB10-11, IRBB13-14, IRBB21, IRBB50-55, IRBB59-60), Gigante and IR24.

F5 - Flagship progress:

In CoA5.1 (Harnessing genetic diversity), screening and validation experiments using germplasm panels and populations resulted in the discovery of novel donors and genomic regions associated with anaerobic germination, stagnant flooding, grain Zn content, sheath blight tolerance, and drought/direct seeded rice.

CoA5.2 (Precision breeding) reports loci controlling extreme early flowering and maturity of a Madagascan landrace identified, and introgression advanced to BC4 generation. Deployment of some 12 genes into IRRI154 was completed; for most this is the first time they have been available in an elite background.

In CoA5.4 (Unfavorable ecosystems), phenotypic evaluation of the rainfed-core breeding panel across Asia and Africa was conducted. A set of 296 lines was screened in 11 sites in South Asia and 8 sites in East and Southern Africa.

In CoA5.5 (Grain quality and nutrition), we developed holistic phenotyping tools to identify superior germplasm with head rice yield and lowering chalk and identification of QTLs.

In CoA5.6 (Modernizing rice breeding), we used CIAT's gene bank diversity to identify different traits for disease resistance like blast, rice *hoja blanca* virus and *striga*, also we worked in abiotic stress like heat tolerance and yield related traits like panicle architecture.

Detailed Annex:

In CoA 5.1 (Harnessing genetic diversity), screening and validation experiments using germplasm panels and populations resulted in the discovery of novel donors and genomic regions associated with anaerobic germination, stagnant flooding, grain Zn content, sheath blight tolerance, and drought/direct seeded rice; 50 potential donors have been selected for gap analysis with DST elite lines and a BIL (*rufipogon x indica*)

was selected for use in the stress breeding program.

JIRCAS screened 250 accessions from the 3K panel for grain Zn concentrations and identified 2 potential new donors combining above-average yield with grain Zn concentrations above 35 ppm. It developed a genomic prediction (GP) model to estimate grain Zn concentrations among the 3K accessions to facilitate the identification of additional donors.

CoA 5.2 (Precision breeding) reports loci controlling extreme early flowering and maturity of a Madagascan landrace identified, and introgression advanced to BC4 generation. Deployment of some 12 genes into IRRI 154 was completed; for most this is the first time they have been available in an elite background. Over 100 trait markers targeting 55 high-value loci designed and implemented at 3 different service providers. The RiCA panel implemented at DArT in Australia to provide an alternative to Agriplex. Introgression of RYMV resistance genes advanced, with progeny starting to show some restoration of fertility. Analysis tools to convert trait marker information to easily-interpreted trait calls developed and distributed to partners. The core 25 lines from the Irrigated core panel were sequenced, and plans are in place to sequence the remainder.

For CoA5.4 (Unfavorable ecosystems), phenotypic evaluation of the rainfed-core breeding panel (RCP 1.0) across Asia and Africa was conducted in the year 2019. A set of 296 lines was screened in 11 sites in South Asia and 8 sites in East and Southern Africa. One QTL for stagnant flooding tolerance was identified using a bi-parental population. The results of this study are now being compiled as a manuscript. International Network for Genetic Evaluation of Rice (INGER) a rice germplasm testing network sent rice germplasm trials in 18 countries (79 locations for biotic stress and 88 locations for abiotic stress). Multiple breeding lines were nominated in release pipelines or released as new varieties for countries in South and South East Asia. Some of these include IR10F365 and IR13F265 for flood prone areas in Philippines; IR13F115 and IR12F578 for flood prone areas in Nepal, Bahuguni dhan 1 and 2 for flood and drought prone areas in Nepal and Inpari 46 for rainfed lowland drought and coastal saline regions in Indonesia. IR13F265 is identified for release in the Philippines.

Pre-breeding for lowered glycemic index with acceptable texture was conducted. Reliably generating rice varieties with low glycemic index (GI) is an important nutritional intervention given the high rates of Type II diabetes incidences in Asia where rice is staple diet. We integrated a genome-wide association study (GWAS) with a transcriptome-wide association study (TWAS) to determine the genetic basis of the GI in rice. GWAS utilized 305 re-sequenced diverse *indica* panel comprising ~2.4 million single nucleotide polymorphisms (SNPs) enriched in genic regions. A novel association signal was detected at a synonymous SNP in exon 2 of LOC_Os05g03600 for intermediate-to-high GI phenotypic variation. Another major hotspot region was predicted for contributing intermediate-to-high GI variation, involves 26 genes on chromosome 6 (GI6.1). These set of genes included GBSSI, two hydrolase genes, genes involved in signaling and chromatin modification. The TWAS and methylome sequencing data revealed cis-acting functionally relevant genetic variants with differential methylation patterns in the hot spot GI6.1 region, narrowing the target to 13 genes. Conversely, the promoter region of GBSSI and its alternative splicing allele (G allele of Wxa) explained the intermediate-to-high GI variation. A SNP (C>T) at exon-10 was also

highlighted in the preceding analyses to influence final viscosity (FV), which is independent of amylose content/GI. The low GI line with GC haplotype confirmed soft texture, while other two low GI lines with GT haplotype were characterized as hard and cohesive. The low GI lines were further confirmed through clinical in vivo studies. Gene regulatory network analysis highlighted the role of the non-starch polysaccharide pathway in lowering GI.

To accomplish the 1.3% of genetic gain in intensive systems, CIAT-FLAR tested 30 breeding lines in multi-environmental trials in six countries of LAC in the FLAR network. Four varieties of CIAT-FLAR germplasm were released in three countries of LAC. In unfavorable ecosystems, CIAT identified two QTLs for drought stress. For high-quality and nutritious rice, CIAT-CIRAD-Harvest plus release a high zinc varieties in Bolivia and Colombia increasing around 8 ppm the zinc content. In terms of quality improvement we develop and validate in 2019, three molecular marker for amylose content, gelatinization temperature and chalkiness, key components of rice quality.

JIRCAS developed near isogenic lines(NILs) for true blast resistance genes, Pii, Pi3, Pik, Pik-h, Pikp, Pi1, Pi7(t), Piz, Piz-5, Pi9(t), Pi12(t), Pish and improved resistance was confirmed by an inoculation test with international standard differential blast isolates. To develop NILs for partial resistance genes (pi21 and PB1) hybrid populations (BC5F2 and BC6F2) were generated for the selection of homozygous plants

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

A) Have any promising research areas been significantly expanded?

In FP1, impact evaluation of rice technologies has mostly been dominated by localized, small scale and project-driven studies. Two research areas were expanded:
- The first study was initiated in Bangladesh to estimate through surplus analysis the rate of returns and other welfare measures for IRRI investment on varietal improvement, agronomic practices dissemination and capacity development.
- The second study was initiated to assess the impact of stress-tolerant varieties in India and Bangladesh using remote sensing and econometrics methods.

FP2 research has further expanded from value chain upgrading to food systems research, contributing to the 'Improved diets for poor and vulnerable people IDO'.

In FP3, AfricaRice initiated assessment of impact of different rice cultivation methods on yield, water input, GHG and mosquitoes in paddy fields in Côte d'Ivoire in collaboration with colleagues from the London School of Hygiene and Tropical Medicine. This activity was linked to outcome “Improved rice management practices that reduce GHG by 5% disseminated at three action sites”, in which AfricaRice did not contribute before.

In FP5, Work on the early-maturity loci has expanded as this represents a mechanism to greatly reduce the time required to deploy new genes.

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

In FP1, the policy engagement to develop a rice value chain in Papua New Guinea was interrupted after the first stakeholders workshop due to lack of funding commitment by DFAT to pursue the project. The resources allocated under W1W2 were not sufficient to pursue this activity. The workshop on policy engagement in Indonesia took place in January 2020 instead of late 2019. This was due to a change in FAO's schedule in response to a request made by the Government.

In FP2, since the development of a repository for product profiling under the bilaterally-funded AGGRi Alliance is in progress, some work on product profiling in Philippines, Cambodia and Bangladesh was postponed to 2020.

In FP4, trial establishment at sites in China was delayed. Grain quality analyses for trials from three IRRI Philippine and one Myanmar site were planned but could not be done due to lack of funds. Establishing drone-based phenotyping at 2 locations in India (Titabar and Maruteru) was unsuccessful due reduced staff and partner interest. Training workshops and visits to partner sites were not possible due to lack of funding. Delays in hardware acquisition continued to stall image processing and field surveying activities by other partners.

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

In FP1, the experimental study on group contracts and sustainability in smallholders' seed production was made possible by aligning with CSISA project activities in India. A randomized control experiment was conducted on the impact of contract farming in Benin and shows that contracts which only include an agreement on price have nearly as large of an impact as did contracts with additional attributes.

In FP2, CoA 2.2 has completed the piloting of value chain support services in Cambodia and re-focused on Burundi in Africa. We believe that there are a lot of lessons learned in Asia that can be applied in Africa for mechanization and postharvest. Value chain support services are far less developed in Africa than in Asia, and they are a pre-condition for value chain upgrading.

FP5 changed the direction of the original C4 cluster of activities for modernizing rice breeding. We are implementing changes within the breeding program for rapid generation advance to increase the genetic gain. In addition, we explore the use of genomic selection in recurrent selection schemes and for 2022 we expect to have it completely integrated to the breeding program

1.2.4 Altmetric and Publication highlights (max. 400 words)

The following papers had high altmetric scores (on 18 March 2020):

1. Zaidi, S. S. e. A.; Vanderschuren, H.; Qaim, M.; Mahfouz, M. M.; Kohli, A.; Mansoor, S.; Tester, M., 2019. New plant breeding technologies for food security, Science, volume 363, no. 6434; pages 1390-1391; https://doi.org/10.1126/science.aav6316. Altmetric score 41.

This paper argues that with careful deployment and scientifically informed regulation, new plant breeding technologies (NPBTs) such as genome editing will be able to contribute substantially to global food security. Achieving global food security will require a framework based on the lessons learned from the past: Innovation is essential, and thus an environment facilitating innovation is also essential. In order to fully exploit the potentials of NPBTs, a multipronged approach is needed, taking into consideration all components involved in technology development, dissemination, adoption, and social acceptance (see the figure). NPBTs should not be misunderstood as a panacea. Many other technologies and approaches are needed as well, including improvements in postharvest management, market infrastructure, and social services. However, genome editing is predicted to be a powerful addition in the fight against hunger and poverty. The global community should seize this opportunity by developing conducive regulatory frameworks and support mechanisms.

2. Oliva, Ricardo; Atienza-Grande, Genelou; Auguy, Florence; Cunnac, Sébastien; Dossa, Gerbert S.; Eom, Joon-Seob; Frommer, Wolf B.; Huguet-Tapia, José C.; Ji, Chonghui; Li, Chenhao; Li, Ting; Liu, Bo; Luu, Van T.; Nguyen, Hanna; Perez-Quintero, Alvaro; Schmidt, Sarah M.; Sciallano, Coline; Slamet-Loedin, Inez H.; S zurek, Boris; Vera Cruz, Casiana; White, Frank F.; Yang, Bing, 2019. Broad-spectrum resistance to bacterial blight in rice using genome editing, Nature Biotechnology; https://doi.org/10.1038/s41587-019-0267-z. Altmetric score 36.

Bacterial blight of rice is an important disease in Asia and Africa. The pathogen, *Xanthomonas oryz*ae *pv.oryzae* (Xoo), secretes one or more of six known transcription-activator-like effectors (TALes) that bind specific promoter sequences and induce, at minimum, one of the three host sucrose transporter genes SWEET11,SWEET13 andSWEET14. We used CRISPR–Cas9-mediated genome editing to introduce mutations in all three SWEET gene promoters. Editing was further informed by sequence analyses of TALe genes in 63Xoo strains, which revealed multiple TALe variants for SWEET13 alleles. Mutations were also created in SWEET14, which is also targeted by two TALes from an African Xoo lineage. A total of five promoter mutations were simultaneously introduced into the rice line Kitaake and the elite mega varieties IR64 and Ciherang-Sub1. Paddy trials showed that genome-edited SWEET promoters endow rice lines with robust, broad-spectrum resistance.

1.3 Cross-cutting dimensions (at CRP level)

1.3.1 Gender (max. 750 words)

A) List any important CRP research findings

In India Women-headed households, caste groups exhibit higher adoption rates for stress-tolerant rice varieties. Engagement of women as seed producers is beneficial for adoption. Women users prefer seed from women producers due to easier access and trust in quality. Zossou et al. (2019) analyzed factors that influence farmers in acquiring agricultural knowledge and adopting technologies 5 African countries. Gender gap was observed in Côte d'Ivoire and Niger, on knowledge about agricultural technologies and use of improved farming methods.

The adoption of "smart-valley approach" increased yield by 0.9 t/ha and income by 267 US$/ha in Benin. The impact is greater for men than for women (0.95 tons/ha for men and 0.88 tons/ha for women). The adoption of Smart-Valley technology in Togo showed that despite the participation of female farmers in trainings on the technology, the implementation by women was limited by the required physical effort and labour. Women's role in Smart-Valley adoption remains relegated to less labour-demanding, less rewarding activities (e.g. fetching water, preparing meals).

FP2 has further expanded its research and training portfolio on market analysis for gender-responsive product profiling. Consumer demand for rice fragrance in South and Southeast Asia is found to be mainly driven by women. These insights can assist rice breeding programs in developing gender-responsive product profiles (Bairagi et al., 2020 , British Food Journal). Demand for heritage rice produced by indigenous communities is found to be mainly driven by women. This can inform cultural heritage preservation strategies based on the commoditization of heirloom rice (Bairagi et al., under review, Agriculture and Human Values). A qualitative study conducted in five communes in Benin found that the GEM parboiler lifts more women out of poverty than men. In Casamance (Senegal), rainfed rice cultivation is found to be predominantly a female activity. Women have limited access to motorization and inputs, though. Food security can be enhanced by increasing women's labor productivity through improved access to production factors.

On-farm survey was initiated with the aim to determine linkage between farm diversification with on-farm diet considering factors including market, income and women empowerment within the context of the rice farming system in Madagascar, Nigeria, Rwanda, and Senegal. In Rwanda, the nutritional status in female-headed households (20% of entire surveyed households) is lower than in male-headed households in the above survey.

Results from interview with female farmers joining participatory evaluation of vegetable and legumes species as off-season crop in lowland rice revealed that whereas the income from rice is jointly managed by spouses in households, the income from vegetable growing such as green leaves and fruit vegetables (e.g. tomatoes) is almost exclusively managed by women. The system hence gives an opportunity to women to actively contribute to the household's livelihoods.

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

An assessment of women challenges and opportunities in rice production in Senegal showed that traditional rice production activities are threatened by increasing biotic constraints. From a gender perspective, these conditions are worrisome because they are limiting the essence of the role of the woman in the household. Rice growing in the lowland fields is a traditional activity of the woman and producing rice is essentially the woman's contribution to the household's food consumption.

A novel indicator for women empowerment was developed. Women were found to be more empowered if they were engaged in off-farm employment, which argues for increasing gender inclusiveness of rice value chain upgrading (Maligalig et al., 2019, Journal of Rural Studies). Indicators elicited through gamification experiments are found to be an efficient way for measuring empowerment. FP2 will facilitate spillover of this method to food choice research (e.g., Bairagi et al ., 2020 in the British Food Journal).

Recently, looking at product profiles from a gendered lens is being incorporated in FP4 research. Therefore, in the long-term, products will benefit women and men depending on their requirements.

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

There was no problem in relation to gender issues. However, the reduction in W1W2 budget limited the scope of planned activities. During the MELIAG workshop, a session was organized on the analysis of gender markers in innovations, evidence reports, policies.

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

To promote youth employment in the rice value chain within the PEJERIZ project (funded by CTA-EU/ACP), 103 youth business plans were developed (52 business plans for Senegal and 51 for Mali representing 38% female and 62% male).

A youth strategy has been developed and is now under review for publication. The strategy is built on a resilience framework and is designed with a goal of engaging youth in inclusive and sustainable way

Analysis of the rice production systems showed that there is no significant difference in term of yield and profitability between youths and adults in Senegal and Mali

120 youth seed entrepreneurs trained by AfricaRice in Ibadan between 2016 and 2018 have engaged other youths in the seed production businesses across six states in Nigeria. Tangible achievements include selling seeds to off-takers, to seed-producing projects, undertaking other activities such as providing out-grower services for industrial rice processors and other individual asset gains.

FP2 has conducted a study on preserving cultural heritage of indigenous rice communities in the northern

Philippines through commoditization of heirloom rice. Results indicate a potential market size of PHP 15.7 billion (USD 344 million) that could be created for heirloom rice and tapped into by heritage farmers (Bairagi et al., under review, Agriculture and Human Values). FP2 published a policy article on inclusiveness of contract farming in Vietnam. The findings highlight the role policies encouraging horizontal and vertical coordination can play in fostering inclusiveness in rice value chain upgrading (Ba et al., 2019 , Land Use Policy). The curriculum development for Agricultural Engineering (BSC) and Agricultural Machinery Mechanics done in In CoA 2.2 in Cambodia resulted in around 20 graduates of each course leaving entering the agricultural job markets in Cambodia each year. FP2 engaged 65,000 smallholder farmers, parboilers and marketers in GEM parboiling related activities in five African countries (Benin, Cote d'Ivoire, Niger, Nigeria, Togo). More women and youth are now involved in rice processing following the installment of GEM parboiled rice processing facilities in several sites across Africa. The GEM rice processing facilities provide poor farmers who are vulnerable to paddy collectors the option to add value to their rice before selling. A study on the rice value chain in Côte d'Ivoire has identified drivers of farmer inclusion in contract farming and the drivers of improved seed adoption.

IRRI South Asia Office in India convened a multi-sectoral panel discussion on - "Creating Sustainable Value Chains for Transforming Food Systems" on 4 February, at the National Agricultural Science Complex in Delhi. One of the key recommendations that emerged was the pressing need for developing and strengthening robust and sustainable value chains with appropriate cropping and mixed livestock/fish systems tailored for specific agro-ecologies in India and South Asia. In the interim, the fortification and/or biofortification of staple crops with iron, zinc, and beta-carotene, low glycemic index, and low arsenic can help address the challenges of poor nutrition and unsafe food, among the more vulnerable consumers, especially women and children, in India. A policy brief are under development based on the outcome of this workshop.

Direct-seeded and rainfed breeding programs lead to the development of suitable varieties for risk prone systems. The reduction in risk associated with crop failure and possibility of mechanization of farm activities may lead to greater engagement of youth with rice farming.

Analysis of rice production systems in Senegal and Mali showed no significant difference in yield and profitability between youths and adults.

A) List any important CRP research findings

Analysis of the rice production systems showed that there is no significant difference in term of yield and profitability between youths and adults in Senegal and Mali.

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

The youth trained by AfricaRice engaged in seed-producing projects (IFAD-VCDP in Benue State), undertook other activities such as providing out-grower services for industrial rice processors and other individual asset gains (e.g. purchase of tractor from sales of seed).

Data from on-farm surveys in Rwanda and Senegal revealed that youth farmers were very limited. They (age between 18 and 35) were 13 and 6% in Rwanda and Senegal, respectively. Farmers were 49 and 54 years old on average. This aging issue was not considered in FP3. Further research requires constraints related to this aging issue, and youth participation in rice farming.

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

None

1.3.3 Capacity Development (max. 300 words)

A complete overview of all trainings provided by RICE can be found in the open-access GRiSP file cabinet: http://www.grisp.net/file_cabinet/folders/277692 . For short-term trainings, detailed information is given on type and location of training while for short term trainings, the numbers are split out among BsC, MsC, PhD, and others (on the job trainings, interns), all gender disaggregated.

A few examples of typical capacity development activities were:
- In Philippines, a national 'retooling' of trainers was conducted to enhance the capacity of agricultural extension workers for crop health assessment including identification and ecologically based management of rice diseases, insect pests, rodents, and weeds. 46 trainings were attended by 1,617 participants.
- In Africa, 622 NARS partners (71% women) were trained on rice statistics, impact assessment, and data collection using automated methods. Training on the use of ICT and social media for agribusiness were organized for 204 youth agripreneurs (32% female). Before the training, only 3-13 % had good experience in the use of ICT and social media in agribusiness. After the training, over 70 % of the youth are willing to use the ICT and social media tools.
- 314 farmers and service providers received training in use of RiceAdvice in Burkina Faso, Mali, Nigeria, and Senegal. Good Agricultural Practices (GAP) was disseminated to rice farmers by establishing 73 demonstration plots (47 in Madagascar and 26 in Uganda) managed by lead farmers who were trained in GAP at the beginning of the season. 6,000 others learned about GAP through the organized field days and regular exchanges within farmers groups and communities in Madagascar and Uganda.
- 64 value chain actors (30 men and 34 women) were trained in marketing strategies and post-harvest handling in Madagascar.

1.3.4 Climate Change

IRRI's results in low-emission rice cultivation in the Mekong River Delta of Vietnam have been demonstrated and disseminated to policy makers and development organizations through research papers, technical guides, and national/regional workshops. In 2019, IRRI proposed a roadmap for adopting low-emission technologies in rice production including AWD-suitability maps for An Giang province. The Department of Crop Production under Ministry of Agriculture and Rural Development highly appreciated the mapping methodology and requested for IRRI's continued assistance in AWD scaling process in other Mekong River Delta provinces. Furthermore, IRRI developed a blueprint guiding national partners to plan, finance, and implement agricultural NDC. Supported by RICE and other

partners, the National Agriculture Extension Center, formally launched the training materials on climate-smart production.

Almost all postharvest practices developed under FP2 are related to climate change, optimizing operations leads to reduced energy consumption and this less emissions and reducing postharvest losses also reduces emissions created by manufacturing and applying the inputs used for growing and processing the lost grains. We have conducted Live Cycle Assessments comparing various operations and technologies (e.g. drying systems, different rice straw management options, etc.) which resulted in science based evidence about environmental sustainability of those options. The output of this work has been used in formulating the postharvest indicators for the Sustainable Rice Platform (SRP) and policy workshops have been conducted in Vietnam, Cambodia and the Philippines using this data.

AfricaRice and Wageningen Plant Research (http://www.grisp.net/file_cabinet/folders/270) showed that African farmers can adapt to climate change by changing varieties, sowing dates and the number of crops per year. Climate change would reduce rice yield by 37% while with adaptation, there could be up to 121% yield increases. More information on vegetable responses to climate change is required for diversified cropping systems.

2. Effectiveness and Efficiency

2.1 Management and governance (max. 300 words)

No changes in the RICE management or governance structure occurred in 2019; terms of references of governance and management bodies can be accessed here (http://www.grisp.net/file_cabinet/folders/265910). The RICE independent steering committee met in September 2019 and detailed minutes are publicly available and can be accessed here (http://www.grisp.net/file_cabinet/folders/265910).

2.2 Partnerships

2.2.1. Highlights of External Partnerships (300 words)

In 2019, the six RICE centers (AfricaRice, CIAT, IRRI. Cirad, IRD, JIRCAS) mapped 266 ongoing bilateral projects to RICE. Through these projects, and through the RICE flagship projects, the six RICE centers had a total of 391 contractual partners, many of whom had their own partners in country for further collaboration. Complete partner lists by contractual RICE center, with details on type of partners and the main country or geography of work of partners, can be found at http://www.grisp.net/file_cabinet/folders/277692.

A few partnership highlights are:
- The African Development Bank mandated AfricaRice to lead the development of the 'Continental Investment Plan for accelerating Rice Self-Sufficiency in Africa' to support African countries to attain rice self-sufficiency.
- An emerging partnership with international organizations and universities (University of Arkansas, Purdue University, University of Washington, FAO, OECD - Organization of Economic Cooperation and Development) to investigate the role of policy support in curbing GHG emissions and to develop outlooks of the rice economy.
- A new partnership was established with the Islamic Development Bank to implement the Regional Rice Value Chain Program in 10 African countries.
- Partnership with the Latin American Fund for Irrigated Rice (FLAR) - a public-private partnership of over 30 organizations in 17 Latin-American countries, providing advice on improved crop management and technology adoption.
- The Direct Seeded Rice Consortium is a public-private multi-stakeholder research for development platform on direct-seeded rice, with 26 members, out of which 8 are from private sectors.
- The 'AGRITECHNICA ASIA Live' event in Myanmar was an effective model for public-private partnerships. This event was co-organized by IRRI, the Myanmar Rice Federation, the German Agriculture Society, Myanmar Agricultural Mechanization Department.
- Partnership with GrainPro on the introduction of hermitic storage systems in Africa.
- Partnership with Corteva Agriscience enabled genomic selection and increased selection accuracy.

2.2.2. Cross-CGIAR Partnerships (300 words)

Partnerships with the cross-cutting Platforms EiB and Big Data, were strengthened considerably, specifically to align/harmonize phenotyping protocols, methodologies for genetic analysis and data management systems, and tools and methods to modernize rice breeding programs.

A joint Genebank-RICE impact assessment of the International Rice Genebank (IRG) on Improved Rice Varieties in Eastern India revealed that 45–77% of the genetic composition of improved rice varieties comes from the genes of IRG accessions (Villanueva et al. 2019). A 10% increase in the genetic contribution of IRG accession on an improved rice variety increases the yield by 27%.

In collaboration with PIM, new partnerships were forged between IRRI, IFPRI, CIAT, CIMMYT, and AfricaRice primarily in the context of the CGIAR foresight report which requires collaboration on some modelling issues. It is fundamental for the RICE CRP to show case its own foresight work to be credible and access platforms where global foresight work is undertaken.

Agronomists from 9 CGIAR centers (AfricaRice, CIAT, CIMMYT, CIP, ICARDA, ICRISAT, ICRAF, IITA, and IRRI) jointly developed concept paper on "Excellence in Agronomy Initiative". Joint project proposal is under development and is submitted to BMGF in 1st quarter in 2020.

FP2 has deepened collaboration with the cross-cutting CRP A4NH (Agriculture for Nutrition and Health) through the BMGF-funded Drivers of Food Choice (DFC) Competitive Grants Program.

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)

The annual RICE MELIAG (Monitoring, Evaluation, Learning, Impact Assessment, Gender) workshop was held in September 2019 to facilitate scientists' understanding and knowledge in using the MARLO reporting and planning platform. The MELIAG workshop allows coordinating the reporting and reviewing of flagship progress on RICE milestones and indicators in the MARLO platform. Through this workshop several MELIA-related outputs and outcomes were generated. Evidence gaps needed for supporting outcome case reports were identified.

In May 2019, FP 1 organized a workshop to review MEL practices among RICE partners and external partners to get insights and challenges in implementing a coordinated MELIA for the whole of RICE CRP. A workshop was organized in Tanzania to build understanding on the role and needs of rice millers to accelerate rural transformation. The workshop on Rice Statistics was organized in Nairobi from 19-20 June 2019.

2.5 Efficiency (max. 250 words)

Collaboration among RICE centers is leading to efficiency gains and research spillovers. A specific example is given for Flagship Project 2, which is highly efficient given the output it generates in terms of innovations, publications etc., and transformative outcomes in terms of technology transfer, scaling-out, knowledge transfer, capacity building, policy influence, etc. under the limited financial and human resources. The efficiency of FP2 is probably due to the high coherence and complementarity of the activities within a logical framework of rice value chain upgrading.
- The successful publication of "The state of rice value chain upgrading in West Africa" forthcoming in Global Food Security in 2020) can be explained through the following factors:
- RICE-FP2's common rice value chain upgrading framework.
- Presence of CIRAD and AfricaRice on the ground and their expertise of the rice sector.
- Contribution of CIRAD's conceptual framework on value chain analysis (Soullier et al., 2020, Development Policy Review).
- Contribution of IRRI's theoretical framework on comparative advantage in demand (Demont, 2013, Global Food Security; Demont et al., 2017, World Development).
- Good working relationship among FP2 scientists from IRRI, CIRAD and AfricaRice.
- Presentation of findings at international conferences and feedback from participants: (i) Fifth International Rice Congress, Singapore, 2018; (ii) Regional workshop on "Leveraging small and medium rice millers for rural transformation and investment in the rice sector in Africa," Dar es Salaam, Tanzania, 2019.

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

Programmatic risks: The main risk was again W1W2 budget uncertainty and decline, which was mitigated by conservative use of W1W2.

Contextual risks: The conflict in Mali represents a real threat for the promotion of youth entrepreneurship in rural area. The outreach of farmer for access to improved technologies could be jeopardized given the non-accessibility to some key rice growing areas. The policy engagement in The Philippines went reasonably well as far as the analytical activities of the process are concerned. However, by end of 2019, it was not clear whether IRRI's policy engagement could substantially influence the Philippines government thinking on the next steps of the Rice Tariffication. This is mostly due to a lack of recognition of IRRI as a major interlocutor on policy matters. The result of the value chain analysis in Indonesia seems promising. This project is highly regarded by the Minister of Agriculture. Insecurity in the Niger Office prevented a field mission from CIRAD staff.

Institutional risks: In 2019, several talks were initiated about the scenarios of merger, unification, and alignment between IRRI and Africa. The main projected risk was the future of planned CRP activities in case any of these scenarios had happened. Uncertainty remains high around One CGIAR reorganization and its effect on business continuity for CRPs. At IRRI, the Agri-food policy platform has defined and

implemented a more stringent data policy consistent with the risk management strategy of IRRI. The new policy ensures consistency in data treatment and reduces the delay before analysis.

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

In general, W1,2 funding provided the backbone of RICE and catalyzed impact through strategic investments along the whole impact pathway, from upstream research to downstream development of business models and multistakeholder partnerships for innovation and scaling out. W1,2 investments included both the research and product development component of the impact pathway as well as the strengthening of the enabling environment (as per Theory of Change). The long-term nature of W1,2 funding provides the continuity to the program, and guarantees both short-term and long-term impacts on 5-10 year time scales.

With the declining W1W2 budget, the available fund for most Flagship projects was used conservatively to support staff time and planned activities. In several cases, the W1W2 fund was used to leverage with existing bilateral grants. With the limited number of staff available, several research activities were implemented through consultancies funded by W1W2. For instance, the development of youth strategy report was made possible through expert consultancy. Also, a consultant was hired to conduct the study on returns to IRRI investment in Bangladesh. The impact assessment study on stress-tolerant varieties was made possible through SPIA grant with co-funding from RICE W1W2. The W1W2 pre-investment in drafting the proposal has been instrumental in securing the SPIA grant. More examples of use of W1,2 funding are provided in Table 12.

3. Financial Summary

For 2019, a RICE W1,2 budget of 13.4 M US$ was approved by the System Council – down from 15.75 M US$ in 2018. Though the relative share of W1,2 funding has decreased, it still provides the backbone of RICE and catalyzes 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 cover 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), eg through capacity development and partnership building. The long-term nature of W1,2 funding provides the continuity to the program, and guarantees not only short-term impacts (as derived from most bilateral projects) but also long-term impacts on 5-10 year time scales. Most W1,2 funds are used to support key RICE and flagship project staff, key MEL activities across all projects and funding sources, gender analyses and gender mainstreaming, capacity development and partnership building for scaling out and achieving impact at scale, and new initiatives (such as farm diversification, value-chain analyses).

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
100 million more farm households have adopted improved varieties, breeds, trees, and/or improved management practices.	The Green Super Rice project has developed and released 59 improved rice varieties covering over two million hectares in 11 countries in Southeast Asia, South Asia, and East and Southern Africa (IRRI news, Yu et al., 2020). Up to end of 2019, the CORIGAP project reached 758,196 farmers with best practices for lowland rice production across six Asian countries: Myanmar, Sri Lanka, Indonesia, Thailand, Vietnam, and China. About 132,000 farmers have adopted best practices and increased their rice yield by 11-20%, and profit by 13-25%. Saito et al., (2019) showed that the adoption rate of rice variety WITA 9 was 24% in Cote d'Ivoire. 2,674 out of 8,003 rice farmers censured have cultivated WITA 9 in Cote d'Ivoire in 2018/2019. As of September 2019, there were 3,495 reapers in Nepal's Terai and almost 16,000 ha of rice and wheat was being harvested by them (CSISA annual report 2019 , pp. 54).	NA
30 million people, of which 50% are women, assisted to exit poverty	About 132,000 farmers in in Myanmar, Sri Lanka, Indonesia, Thailand, Vietnam, and China have adopted best management practices introduced by the CORIGAP project and increased their profit by 13-25%. Arouna et al. (2019) showed that adoption of RiceAdvice in Nigeria increased income by about $227, the equivalent of 20 percent over control households. In Nigeria, the use of RiceAdvice had 20% higher profits. Arouna and Aboudou (2019) showed that adoption of drought-tolerant rice varieties increased the rice income by US$ 126 per ha and also improved household food security in Benin, Madagascar and Nigeria. Saito et al., 2019 showed that adoption of rice variety WITA 9 increased farmer's income by US$ 91 ha–1 per season.	NA

2.5 million ha of forest saved from deforestation	NA for RICE	NA for RICE
Improve the rate of yield increase for major food staples from current < 1% to 1.2-1.5% per year	Arouna et al. (2019) showed that adoption of RiceAdvice in Nigeria increased yields by 549 kg/ha (+15%). About 132,000 farmers in in Myanmar, Sri Lanka, Indonesia, Thailand, Vietnam, and China have adopted best management practices introduced by the CORIGAP project and increased their rice yield by 11-20%. Adoption of mini-tillers in Nepal showed increased productivity by 1,110 kg/ha (Paudel et al., 2019). Arouna and Aboudou (2019) showed that adoption of drought-tolerant rice varieties increased the rice yield by 570 kg/ha (24% increase) in Benin, Madagascar and Nigeria. Saito et al., 2019 showed that adoption of rice variety WITA 9 paddy in Cote d'Ivoire gave a yield advantage of 0.7 t ha–1. In Brazil, in 2018-2019, 118 demonstration plots were cropped using improved practices, covering an area of 3,790 hectares, realizing an average yield of 9,400 kg ha-1, 12% higher than conventional management. In a three-year average, yields were 19% higher.	NA
30 million more people, of which 50% are women, meeting minimum dietary energy requirements	None this year	NA
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	The first High-Zinc Rice 1 (NSICRc 460) was released in the Philippines. IR10M300 was found to be the most stable genotype across seasons in terms of yield and grain Zn. IR10M300 has a yield of 4690.3 kg ha−1 and grain Zn of 18.3 ppm. It outperformed two rice variety checks (PSBRc82 and MS13) for grain Zn with comparable yield with the yield check (PSBRc82) and was successfully released as the first High-Zinc Rice 1 (NSICRc 460) in the Philippines (Inabangan-Asilo et al., 2019). Golden rice is approved for commercialization in the Philippines (New Scientist 2019). For rice-eating countries like the Philippines and Bangladesh, this could help reduce Vitamin A deficiency in vulnerable populations. 100 g of uncooked Golden Rice could supply up to 57% of the estimated average requirement (EAR) for Vitamin A of pre-school children and 38-47% of the EAR for pregnant and lactating women (Swamy et al., 2019).	NA
10% reduction in women of reproductive age who are consuming less than the adequate number of food groups	None this year	NA

5% increase in water and nutrient (inorganic, biological) use efficiency in agro-ecosystems, including through recycling and reuse	A bill was passed in the Philippine congress, encouraging land to be leveled so that mechanization and irrigation are more efficient. The bill also mentions that with this, grain quality, weeding and planting efficiency will be improved, ultimately increasing grain yield. Expected increase of land leveling in farms that will translate in increased water use efficiency (up to 15%), planting efficiency (seed input reduction) and more efficient use of mechanization. In The Philippines, climate-resilient Tatag Hybrid 82 rice link was trialed in South Central Mindanao with reduced irrigation requirements. A 2,000-hectare demo of direct-seeded hybrid rice was successful. The technique could be adopted in the 90,000 hectares that are traditionally direct seeded with inbred varieties in the wet season and the 60,000 hectares during the dry season.	NA
Reduce agriculturally-related greenhouse gas emissions by 0.2 Gt CO2-e yr–1 (5%) compared with business-as-usual scenario in 2022	In December 2019, a suitability map to upscale AWD in Vietnam was presented to the Ministry of Agriculture and Rural Development of Vietnam. The representatives from 11 provinces discussed the ways forward in utilizing the suitability maps in their areas, the barriers for Alternate Wetting and Drying (AWD) - a technology to save water and reduce methane emissions - adoption and solutions to address them. They also identified potential rice production areas to apply full AWD on about 647,000 ha in the Mekong River Delta. In Vietnam , the National Agriculture Extension Center, formally launched the training materials on climate-smart production. The project aims to strengthen the capacity of extension workers in mainstreaming climate change adaptation and mitigation in rice production in the country. The training materials cover specialized topics, such as climate change and greenhouse gas (GHG) emissions in rice production.	NA
55 million hectares (ha) degraded land area restored	NA for RICE	NA for RICE

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	
260 - Regional rice value chain upgrading strategy for West Africa	Regional rice value chain upgrading strategy for West Africa	Level 2	• Reduced market barriers • Conducive agricultural policy environment	1 - Significant	1 - Significant	1 - Significant	0 - Not Targeted	OICR2850
262 - Vietnam policy supports for "1M5R" practice	Vietnam policy supports for "1M5R" practice	Level 3	• Closed yield gaps through improved agronomic and animal husbandry practices	0 - Not Targeted	0 - Not Targeted	1 - Significant	1 - Significant	OICR2861 OICR2746 OICR2841

			• Agricultural systems diversified and intensified in ways that protect soils and water					
264 - Philippine Law No. 10601, otherwise known as "Agricultural and Fisheries Mechanization (AFMech) Law	Contribution to Philippine Law No. 10601, otherwise known as "Agricultural and Fisheries Mechanization (AFMech) Law	Level 2	• Conducive agricultural policy environment • Reduce pre- and post-harvest losses, including those caused by climate chang	0 - Not Targeted	0 - Not Targeted	1 - Significant	1 - Significant	OICR2866
265 - Creating an enabling environment for crowding in private sector investment in sustainable production standards throughout rice value chains in Vietnam	Creating an enabling environment for crowding in private sector investment in sustainable production standards	Level 1	• Conducive agricultural policy environment • Enhanced adaptive capacity to climate risks (More sustainably	0 - Not Targeted	0 - Not Targeted	1 - Significant	2 - Principal	

	throughout rice value chains in Vietnam		managed agro-ecosystems)					
267 - Philippine House Bill No. 4269: An act to promote and accelerate farm land levelign and reconstruction in agricultural production areas, and for other purposes	Contribution to Philippine House Bill No. 4269: An act to promote and accelerate farm land levelign and reconstruction in agricultural production areas, and for other purposes	Level 1	• Conducive agricultural policy environment	? - Too early to tell	? - Too early to tell	? - Too early to tell	1 - Significant	OICR2866
420 - Investment Policy for Rice Self-Sufficiency in The Gambia (CIPRiSSA-The Gambia)	CIPRiSSA helps investors (private and public) to know investment requirements in each segment of the rice value chain as well as the benefits	Level 1	• Increased capacity for innovation in partner development organizations and in poor and vulnerable communities • Conducive agricultural	1 - Significant	1 - Significant	1 - Significant	1 - Significant	The Gambia should attain RSS by 2029 if the country begins in 2019 in making additional investments that could drive and sustain a production growth rate of 26%. Total investments is estimated at US$ 83,198,776 (including US$ 34,166,736 without new irrigation scheme and US$ 49,032,040 for new irrigation schemes). In 2029, the investments will add an additional 232,525 tons of paddy or 147,889 tons of milled rice. 6,140 direct employment

	derivable from such investments for rice self-sufficiency		policy environment					in product processing, wholesale marketing and distribution are expected to be created. The CIPRiSSA was officially launched by the Honorable Minister of Agriculture of The Gambia Mrs Amie Faburay, on 23 April 2019, Banjul.
436 - ECOWAS Regional Rice Offensive	Rice Offensive was launched in 2014 and aimed at a 'Sustainable and sustained revival of rice cultivation toto achieve rice self-sufficiency by 2025 in West Africa'.	Level 1	• Conducive agricultural policy environment	1 - Significant	1 - Significant	1 - Significant	1 - Significant	A few regional initiatives and all the countries focal point presented their support to the rice sector and performance/achievements made in the 10 years of the implementation of the NRDS in their respective countries. Presentations were made by CARI and AfricaRice while ECDPM presented the result of their recently concluded studies in rice marketing in the ECOWAS region funded by USAID. The CARD Secretariat summed up the reports made by country representatives by presenting its findings from a regional perspective. During the first phase, CARI trained 178,000 farmers on Good Agronomic Practices, and also trained 137,281 beneficiaries through farmers' business school. AfricaRice has developed varieties especially the NERICA series that have resulted in the uplift of 8 million farmers out of poverty. In 2015, ECOWAS set the common external tariff (CET) for rice at

								10%, as its member states sought to ensure populations' access to rice. Although member states add other taxes, varying from one country to another, total tariff protection is generally modest and not well targeted, and implementation modalities often reduce its effectiveness. He also pointed out that, in addition to low rate of CET, importers often receive tax exemptions. https://www.riceforafrica.net/meetings-page/regional-workshop/ecowas/ecowas-meeting,-feb-2020
443 - Policy for restructuring the Vietnamese rice sector	The technical assistance developed by IRRI was approved by the Minister of Agriculture and rural development in decree 1889/QĐ-BNN-TT dated 23 May 2016 by MARD Minister.	Level 2	• Conducive agricultural policy environment	? - Too early to tell	? - Too early to tell	1 - Significant	1 - Significant	OICR3263

444 - Access to released varieties in ECOWAS member countries (all ECOWAS 15 countries are member of AfricaRice)	Varieties released by AfricaRice could be used based on the ECOWAS regulation on the harmonization of rules governing quality control, certification, and marketing of plant seeds and seedlings.	Level 2	• Conducive agricultural policy environment • Adoption of CGIAR materials with enhanced genetic gains • Appropriate regulatory environment for food safety	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	0 - Not Targeted	OICR3198 OICR3216

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	Status
OICR2710 - Implementation of satellite-based rice monitoring system in Philippines and the states of Andhra Pradesh and Tamil Nadu of India (updated evidences)	Link	Level 3	Updated Outcome/Impact case at same level of maturity
OICR2746 - Adoption of improved rice management practices in Southeast Asia	Link	Level 2	New Outcome/Impact Case
OICR2752 - Adoption of smart-valley approach in Benin, Togo with Nigeria (as new country in 2019)	Link	Level 3	Updated Outcome/Impact case at same level of maturity
OICR2759 - Women´s participation in decisions about rice variety use and intensity in Ecuador	Link	Level 2	Updated Outcome/Impact case at same level of maturity
OICR2834 - RiceAdvice improved the livelihood of smallholder rice producers in Nigeria	Link	Level 2	New Outcome/Impact Case
OICR2841 - Flat bed dryer adopted in at least 4 countries in Southeast Asia	Link	Level 1	New Outcome/Impact Case
OICR2842 - IRRI Rice Quality Assessment Kit commercialised and marketed globally	Link	Level 1	New Outcome/Impact Case
OICR2845 - Solar Bubble Dryer commercialized and marketed globally	Link	Level 1	New Outcome/Impact Case

OICR2846 - Novel rice varieties for drought, flood prone and coastal saline rice ecosystem	Link	Level 1	New Outcome/Impact Case
OICR2848 - Downdraft rice husk furnace for paddy drying	Link	Level 1	New Outcome/Impact Case
OICR2849 - Raising production and productivity of rice-based cropping systems through Rice Crop Manager in India	Link	Level 2	Updated Outcome/Impact case at same level of maturity
OICR2850 - Implementation of regional rice value chain upgrading strategy in West Africa	Link	Level 2	New Outcome/Impact Case
OICR2851 - Raising production and productivity of rice-based cropping systems through Rice Crop Manager in the Philippines	Link	Level 2	Updated Outcome/Impact case at same level of maturity
OICR2852 - Hermetic Super bags commercialized	Link	Level 1	New Outcome/Impact Case
OICR2856 - Evaluating the usability of Rice Doctor Odisha (RD) as a crop diagnostic tool for extension advisors and farmers	Link	Level 2	Updated Outcome/Impact case at same level of maturity
OICR2861 - Adoption of Laser Leveling in Vietnam and Cambodia	Link	Level 1	New Outcome/Impact Case
OICR2866 - Combine harvesting introduced in Southeast Asia	Link	Level 1	New Outcome/Impact Case
OICR2867 - Adoption of Investment Game Application (IGA) for digital product profiling for rice breeding by NARES partners	Link	Level 2	New Outcome/Impact Case
OICR3198 - Impact of WITA 9 variety on income in Cote	Link	Level 3	New Outcome/Impact Case

d'Ivoire			
OICR3215 - Impact of different contract attributes on rural transformation and welfare of smallholder rice farmers in Benin	Link	Level 2	New Outcome/Impact Case
OICR3216 - Impact of drought-tolerant rice varieties (DTRV) on the livelihood of smallholder farmers	Link	Level 3	New Outcome/Impact Case
OICR3241 - Rice Functional and Genomic Breeding (RFGB) v2.0 database to link genotypic and phenotypic datasets, facilitates access and uploading of genomic data.	Link	Level 1	New Outcome/Impact Case
OICR3262 - Rural outmigration – feminization – agricultural production nexus: Case of Vietnam	Link	Level 1	New Outcome/Impact Case
OICR3263 - A sustainable agri-food system restored through restructuring of the rice sector: Evidence from Vietnam	Link	Level 1	New Outcome/Impact Case
OICR3274 - Impact of CARD initiative on rice productitivty and production in SSA	Link	Level 3	New Outcome/Impact Case
OICR3275 - Impact assessment of Smart-valley approach in West Africa	Link	Level 3	New Outcome/Impact Case
OICR3277 - Rice Galaxy: an open resource for plant science published	Link	Level 1	New Outcome/Impact Case
OICR3295 - Changes in participation of women in rice value chains: Implications for control over decision making	Link	Level 1	New Outcome/Impact Case

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	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
535 - Hermetic Super bag for rice grain and seed storage	Production systems and Management practices	Stage 4: uptake by next user (USE)	Global
536 - Adaptation of flat bed dryer for southeast asian countries	Production systems and Management practices	Stage 4: uptake by next user (USE)	Regional, South-Eastern Asia
595 - SMART-Valleys approach in Benin and Togo	Production systems and Management practices	Stage 4: uptake by next user (USE)	Multi-national

596 - RiceAdvice in Nigeria	Production systems and Management practices	Stage 4: uptake by next user (USE)	National
599 - Cropping calendar construction model	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Multi-national
600 - Alternate wetting and drying (AWD) in Africa	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Regional, Sub-Saharan Africa
605 - Field Calculator	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
607 - Rice Doctor Odiya	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National
609 - AutoMonPH- a decision tool for system level water management using AWD principle	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	National
610 - Improved water governance	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	National

611 - EasyHarvest: App for optimized combine harvester scheduling	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National
612 - Laser land leveling in Cambodia and Vietnam	Production systems and Management practices	Stage 4: uptake by next user (USE)	Multi-national
613 - Laser land leveling in Indonesia, Philippines, Myanmar, Sri Lanka	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Multi-national
614 - Bio-diversified upland rice based cropping systems designing	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	National
616 - Downdraft rice husk furnace for paddy drying (Add license/ agreement/ report of the countries)	Production systems and Management practices	Stage 4: uptake by next user (USE)	Multi-national
617 - Novel training on postproduction and for linking farmers to markets for sustainable rice production	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Global

618 - Rice straw pelleting	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National
619 - Technology and business model for out-door rice straw mushroom production	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Multi-national
620 - Anaerobic digestion of rice straw, household batch system	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National
622 - Training Module: Life Cycle Assessment for Rice Production	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Global
623 - Vocational training program for Agricultural Machinery Mechanics	Research and Communication Methodologies and Tools	Stage 2: successful piloting (PIL - end of piloting phase)	National
624 - IRRI Rice Quality Kit	Production systems and Management practices	Stage 4: uptake by next user (USE)	Global
654 - MINCER micrometerological station used to improve spikelet sterility estimations in crop	Biophysical Research	Stage 3: available/ ready for uptake	Global

models		(AV)	
671 - Multiline variety for blast resistance	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
810 - AfricaRice weather data	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Regional, Sub-Saharan Africa
811 - Scientific understanding of traditional wet-milled rice flour product (Rice flakes)	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, South-Eastern Asia
813 - Pop-rice	Other	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
816 - Weather-rice-nutrient integrated decision support system (WeRise) in Indonesia	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National
817 - Identification of a high-Zinc IRRI-Genebank accession and associated chromosomal positions	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	Global

818 - Weather-rice-nutrient integrated decision support system (WeRise) in Philippines	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	National
819 - Rice Crop Manager - Odisha	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Sub-national
820 - Rice Crop Manager - Philippines	Production systems and Management practices	Stage 4: uptake by next user (USE)	National
821 - Rice Crop Manager - Myanmar	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Sub-national
822 - Weather-rice-nutrient integrated decision support system (WeRise) in Madagascar	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National
823 - Enhanced P-cycling with stylosanthes (*Stylosanthes guianensis*) in upland rice-based cropping systems	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National
825 - Toolkit to capture diversity and drivers of food choice of a target population to identify	Social Science	Stage 3: available/ ready for uptake (AV)	Global

entry points for novel food products and nutritional interventions			
828 - Stomate reduction, gene validation	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
830 - GEM and Mini GEM parboiling technology	Other	Stage 3: available/ ready for uptake (AV)	Regional, Western Africa
831 - Sheath blight tolerance, phenotyping, Genome-Wide Association Study, and validation	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	Global
832 - Training on investment in upgraded milling technologies in West Africa	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Sub-Saharan Africa
834 - Development of a intelligent on-the-fly pipeline for large scale Next Generation Sequencing analyses	Research and Communication Methodologies and Tools	Stage 2: successful piloting (PIL - end of piloting phase)	Global
836 - Food Choice Application (FCA): An interactive tablet applications for capturing	Social Science	Stage 3: available/ ready for uptake (AV)	Global

diversity of food choice			
837 - Identification of non-commonly shared specific genes in wild and cultivated African rices	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
838 - Identification of common genes in cultivated and wild Asian rice (core genome)	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
842 - Low glycemic rice	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	Global
844 - Elite lines with Pi9 introgressed	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
845 - ASI and Mini-ASI Thresher	Other	Stage 3: available/ ready for uptake (AV)	Regional, Western Africa
846 - Development and out-scaling of aromatic hybrid rice varieties in Sub-Saharan Africa	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National

847 - Development and out-scaling of Sub1-introgressed submergence tolerant rice in Madagascar	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	National
848 - Increased sustainability of rice-based systems through use of beneficial rice-microbe associations	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Regional, Sub-Saharan Africa
850 - Red rice improvement for human nutrition and abiotic stress tolerance in Madagascar	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	National
851 - Development of transgressive Tongil varieties to increase yield potentials in irrigated and rainfed lowlands	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	Regional, Sub-Saharan Africa
854 - Interdisciplinary construct of rice quality and multi-country survey providing novel insights on consumers' perceptions of rice quality traits	Social Science	Stage 3: available/ ready for uptake (AV)	Regional, Southern Asia, South-Eastern Asia
855 - Policy sequencing framework for rice value chain upgrading	Social Science	Stage 4: uptake by next user (USE)	Regional, Sub-Saharan Africa

857 - Variety SENACA FL-09	Genetic (varieties and breeds)	Stage 4: uptake by next user (USE)	National
858 - New method and indicator for measuring women's empowerment through gamification	Social Science	Stage 3: available/ ready for uptake (AV)	Global
859 - Rice straw furnace for paddy drying		Stage 1: discovery/proof of concept (PC - end of research phase)	National
860 - Eight (8) rice varieties from CIAT/FLAR origin, available for farmers in Costa Rica, adapted to direct seeding planting system	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National
861 - Paddy drying simulation models	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Multi-national
863 - Variety SENACA FL 11	Genetic (varieties and breeds)	Stage 4: uptake by next user (USE)	National
864 - New method and indicators for measuring inclusiveness of value chain upgrading	Social Science	Stage 3: available/ ready for uptake (AV)	Global

865 - Line 23 for unfavorable ecosystems	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National
866 - Village level value chain upgrading for linking farmers to markets in Myanmar	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National
867 - Rice straw processing for ruminant feeding supplement	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Multi-national
868 - Two (2) high-yielding and long-grained rice varieties available for seeds production and commercialization in Mexico	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National
869 - Investment Game Application (IGA): A new interactive tablet application for digital product profiling for rice breeding	Social Science	Stage 4: uptake by next user (USE)	
870 - Rice lines with 25 ppm Zinc considered for release by Colombia	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National

871 - Indicators and protocol to identify sustainable post harvest management practices	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Multi-national
872 - Herramientas de Costo de Produccion del Arroz CIAT-FLAR v3.3	Social Science	Stage 3: available/ ready for uptake (AV)	Regional, Latin America & the Caribbean
874 - One rice variety available for seeds production and commercialization in Guyana	Genetic (varieties and breeds)	Stage 3: available/ ready for uptake (AV)	National
875 - Technology and Business model for mechanized rice straw collection	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Multi-national, Cambodia, Vietnam, Philippines, Myanmar (Burma)
876 - Market-based incentive mechanism for adoption of sustainable production standards throughout rice value chains	Social Science	Stage 3: available/ ready for uptake (AV)	Regional, South-Eastern Asia
877 - MAC 18 FL: a widely grown rice variety in Bolivia with preferred grain appearance and cooking quality	Genetic (varieties and breeds)	Stage 4: uptake by next user (USE)	National

878 - Approaches for supporting mechanised harvesting in Southeast Asia	Production systems and Management practices	Stage 4: uptake by next user (USE)	Multi-national
879 - Use of African rice to improve human nutrition of rice-eating population in Africa	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Sub-Saharan Africa
880 - An automated approach for mapping inland valleys	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Sub-Saharan Africa
882 - 3-D printing of spare parts for agricultural machinery in developing countries	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Multi-national
883 - Precision fertiliser application in Asia	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Multi-national
884 - Direct seeded rice for Asia	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Multi-national, Bangladesh, Myanmar (Burma), Sri Lanka
885 - Simple and fortified rice wheat biscuits in	Production systems and Management	Stage 3: available/ ready for uptake	Regional, Sub-Saharan Africa

Africa	practices	(AV)	
886 - AfricaRice-TCMS multipurpose grinder	Other	Stage 3: available/ ready for uptake (AV)	Regional, Western Africa
887 - Multi-Piston briquetting technology	Other	Stage 2: successful piloting (PIL - end of piloting phase)	Regional, Western Africa
888 - Gasifier cookstove technology for parboiling	Other	Stage 3: available/ ready for uptake (AV)	Global
889 - Husk fuelled flatbed dryer	Other	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1018 - Sustainable Rice Platform (SRP) Standard and Performance Indicators in Africa	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Sub-Saharan Africa
1019 - Global Yield Gap and Water Productivity Atlas (GYGA) for rice in Africa	Biophysical Research	Stage 3: available/ ready for uptake (AV)	Regional, Northern Africa, Sub-Saharan Africa

1020 - Upland rice-based cropping systems with conservation agriculture in Ivory Coast	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National
1021 - RiceAdvice-WeedManager	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Sub-Saharan Africa
1022 - Mapping abiotic stresses for rice in Africa	Biophysical Research	Stage 3: available/ ready for uptake (AV)	Regional, Sub-Saharan Africa, Northern Africa
1023 - ORYZA2000v2n14s1 for climate change study for rice in Africa	Biophysical Research	Stage 3: available/ ready for uptake (AV)	Regional, Sub-Saharan Africa, Northern Africa
1024 - RiceAdvice in Burkina Faso, Mali, and Senegal	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Regional, Western Africa
1025 - RiceVideo	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	Global
1026 - Management options for salinity in Senegal River Valley	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	National

1027 - Mapping rice area in Senegal River Valley using MODIS time-series and the PhenoRice algorithm	Biophysical Research	Stage 2: successful piloting (PIL - end of piloting phase)	National
1031 - RiceAdvice Voucher System in Nigeria	Other	Stage 1: discovery/proof of concept (PC - end of research phase)	National
1032 - Smart-Valleys approach in Burkina Faso, Liberia and Sierra Leone	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Multi-national
1033 - e-resilient-lowland	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Western Africa
1034 - Forced drainage in Côte d'Ivoire	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National
1035 - Drought prediction in inland valleys rice-based production systems	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Multi-national
1036 - Optimal irrigation scheduling for off-	Production systems and Management	Stage 1: discovery/proof of concept (PC	

season crops	practices	- end of research phase)	National
1037 - Mapping potential irrigated rice area in West Africa	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Western Africa
1038 - One approach for malaria and climate change mitigation in intensified rice production	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National
1039 - Good Agricultural Practices (GAP) in Senegal	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	National
1041 - Inland valley mapping for potential for intensification in Cote d'Ivoire and Ghana	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Multi-national
1042 - GAP (Rice) in Ghana	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Multi-national
1043 - GAP (Rice) in Cote d'Ivoire	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	National

1044 - Flash flood and submergence management with Sub-1 variety with direct seeding in Côte d'Ivoire	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1045 - Integrated Weed Management (IWM) in Rice in Côte d'Ivoire	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Multi-national
1046 - Direct seeded rice using Drum Seeder	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Multi-national
1047 - Crop diversification in lowlands in Côte d'Ivoire	Production systems and Management practices	Stage 2: successful piloting (PIL - end of piloting phase)	Multi-national
1048 - Radio messaging in Côte d'Ivoire	Research and Communication Methodologies and Tools	Stage 1: discovery/proof of concept (PC - end of research phase)	National
1049 - Seeder	Other	Stage 1: discovery/proof of concept (PC - end of research phase)	National
1050 - Fertiseeder	Other	Stage 1: discovery/proof of concept (PC - end of research phase)	National

1051 - Adapted Motorized Weeder (AMW)	Other	Stage 3: available/ ready for uptake (AV)	Regional, Sub-Saharan Africa
1052 - Two-row Motorized Paddy Weeder	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Eastern Africa
1053 - Crop diversification options - Madagascar	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	National
1054 - Rotary weeders	Other	Stage 3: available/ ready for uptake (AV)	Multi-national
1055 - Good Agricultural Practices (GAP) - Tanzania	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National
1056 - Good Agricultural Practices (GAP) - Madagascar	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National
1057 - Good Agricultural Practices (GAP) - Uganda	Production systems and Management practices	Stage 3: available/ ready for uptake (AV)	National

1058 - Micronutrients for rice	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Sub-Saharan Africa
1104 -			
1118 - GEM parboiling methods	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Global
1125 - Rice post harvest loss assessment tool	Research and Communication Methodologies and Tools	Stage 3: available/ ready for uptake (AV)	Regional, Sub-Saharan Africa
1133 - Method for Screening low glycemic rice	Research and Communication Methodologies and Tools	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1134 - Method for screening rice with high popping capacity	Research and Communication Methodologies and Tools	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1193 - Improved rice breeding lines for Madascar and Nepal	Genetic (varieties and breeds)	Stage 1: discovery/proof of concept (PC - end of research phase)	Multi-national, Nepal, Madagascar

1229 - Rice husk fuelled pop rice maker	Other	Stage 1: discovery/proof of concept (PC - end of research phase)	Regional, Sub-Saharan Africa
1230 - Rice variety with high popping capacity	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1231 - Variety for rice cracker production	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1232 - Method for screening rice for cracker production	Production systems and Management practices	Stage 1: discovery/proof of concept (PC - end of research phase)	Global
1237 - Best-fit contract farming models	Social Science	Stage 2: successful piloting (PIL - end of piloting phase)	Regional, Sub-Saharan Africa
1238 - Investissement Policy for Cameroon (CIPRiSSA-Cameroon)	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Cameroon
1239 - Investment Policy for Cote d'Ivoire	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Côte d'Ivoire

(CIPRiSSA-Cote d'Ivoire)			
1240 - Investment Policy for Ghana (CIPRiSSA-Ghana)	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Ghana
1241 - Investment Policy for Madagascar (CIPRiSSA-Madagascar)	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Madagascar
1242 - Investment Policy for Mali (CIPRiSSA-Mali)	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Mali
1243 - Investment Policy for Nigeria (CIPRiSSA-Nigeria)	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Nigeria
1244 - Investment Policy for Senegal (CIPRiSSA-Senegal)	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Senegal
1245 - Investment Policy for Tanzania (CIPRiSSA-Tanzania)	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	National, United Republic of Tanzania

1246 - Investment Policy for Sierra Leone (CIPRiSSA-Sierra Leone)	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Sierra Leone
1247 - Investment Policy for The Gambia (CIPRiSSA-The Gambia)	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	National, Gambia
1287 - Rice Functional and Genomic Breeding (RFGB) v2.0 database to link genotypic and phenotypic datasets, facilitates access and uploading of genomic data	Biophysical Research	Stage 4: uptake by next user (USE)	Global
1288 - Controlled vocabulary dictionary for UAV, phenotyping and image data annotation	Biophysical Research	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1290 - Global rice array antenna and reference panel genotyping data	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1291 - Trial data on the antenna and reference panels were obtained, curated, analyzed, and made available for use.	Genetic (varieties and breeds)	Stage 2: successful piloting (PIL - end of piloting phase)	Global

1292 - Image analysis software (CIAT pheno-i)	Research and Communication Methodologies and Tools	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1293 - Pathotracer, a platform to take informed-decision on rice diseases	Research and Communication Methodologies and Tools	Stage 2: successful piloting (PIL - end of piloting phase)	Global
1365 - Leaf morphology, rather than plant water status, underlies genetic variation of rice leaf rolling under drought	Biophysical Research	Stage 3: available/ ready for uptake (AV)	Global
1406 - ECOWAS Regional Rice Offensive	Social Science	Stage 3: available/ ready for uptake (AV)	Regional, Western Africa
1408 - Rice Galaxy: an open resource for plant science published	Biophysical Research	Stage 4: uptake by next user (USE)	Global
1412 - Proposal for restructuring Rice Sector in Vietnam: Towards 2020 and Vision to 2030	Production systems and Management practices	Stage 4: uptake by next user (USE)	National, Vietnam
1413 - Access of youth agripreneurs to agricultural finance	Social Science	Stage 1: discovery/proof of concept (PC - end of research phase)	Multi-national, Senegal, Mali

1491 -			
1492 -			

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

FP	FP Outcomes 2022	Sub-IDOs	Summary narrative on progress against each FP outcome this year.	Milestone	2019 milestones status	Provide evidence for completed milestones (refer back to means of verification, and link to evidence wherever possible) or explanation for extended, cancelled or changed	Link to evidence
F1	F1 Outcome: Foresight analyses and priority setting used by RICE and partner scientists to develop and target technology options	Increased capacity for innovations in partner research organizations	The IRRI Global Rice Model (IGRM) was updated and upgraded. The baseline developed and calibrated. A few projections were also formulated. New partnerships were forged with IFPRI, FAO, OECD and the University Arkansas on foresight. The IGRM models was also applied to the case of the Rice Tariffication in the Philippines to underpin early and future policy dialogue in late 2019 (Department of Finance and Rice Traders) and in early 2020 (with the Department of Agriculture, and the Central bank), respectively. A workshop was organized in May 2019, in Rome to build a community of practice around cutting-edge methodologies on monitoring, evaluation, as well as ex-post and ex-ante impact assessment among three CGIAR centers of the RICE CRP: IRRI, AfricaRice and CIAT. Technology options were developed and discussed with FP 5 during the MELIAG workshop. Collaboration with PIM allows to systematically collect and compile key foresight activities in the CGIAR Centers. The goal is to identify past foresight analysis that was proven useful, ongoing activities	2019 - 2019 -Workshop to derive major drivers of change expected in the rice sector in the next 3 to 5 years	Complete	The workshop 'Improving impact assessment, monitoring and evaluation of policies, programs, and projects' was organized May 20-24, 2019, Rome, and included sessions with outside partners to explore major drivers of change and develop foresight scenarios.	http://www.grisp.net/file_cabinet/folders/273627

			of significance, planned and/or desired activities. The collaboration consists in producing joint reports and publications to provide evidence and policy support addressing key issues related to food security, income and employment, natural resources and environment.				
	F1 Outcome: Improved role in decision making by women and youth in rice value chains as evidenced by empowerment measures at key action sites	Optimized consumption of diverse nutrient-rich foods	Several gender-related studies and activities have been completed. A youth strategy was developed for Asia and Africa. Several capacity building activities involving women and youth were organized. In India, women-headed households, Scheduled Tribe and Scheduled caste exhibit higher adoption rates for STRVs. Engagement of women as seed producers catalyses adoption. Women users prefer seed from women producers due to easier access and trust in quality. The women empowerment index was computed as 2.86 in Madagascar and 2.4 in Rwanda indicating that the women have some level of decision power, but men dominate the process. For instance, in Rwanda, women consider that their decision power is considered to a high extent in regard to which crop to grow, which rice variety to use, how to use livestock products, how to spend the money earned by the wife herself, her own healthcare and that of children. But women have less voice on how the money earned by the husband should be spent. In Madagascar, women groups serve as channels for empowering women by providing labour and participating in	2019 - Piloting innovative business models on emerging opportunities for women and youth in the rice sector in selected countries in two countries in Asia and Africa each.	Complete	To help overcome the challenges youth face in rural areas, the Promoting youth entrepreneurship and job creation in the West African rice value chain (PEJERIZ) project aims to expand sustainable entrepreneurial and employment opportunities for rural youths by actively engaging them in the improvement of rice value chains.	https://www.cta.int/en/project/promoting-youth-entrepreneurship-and-job-creation-in-the-west-african-rice-value-chain-pejeriz-sid05e536229-5732-44e4-ba7c-4a4f76e8897b

			income generating activities. Women associations serve as channels to access knowledge and skills for seed production, and to have access to land for farming.				
	F1 Outcome: Collective innovation and seed systems	Increased capacity for innovation in partner development organizations and in poor and vulnerable communities	With the declining W1W2 budget research lines on collective innovation and seed systems have been deprioritized. Instead of initiating new studies on seed systems, the limited budget available was used to wrap up pending manuscripts for submission to peer-reviewed journals. The flagship also gave priority to studies funded through existing bilateral projects. Studies on contract farming have mainly occupied this research cluster in 2019 in collaboration with FP2. The experimental study on group contracts and sustainability in smallholders' seed production was made possible by aligning with CSISA project activities in India. In India, women-headed households, Scheduled Tribe and Scheduled caste exhibit higher adoption rates for STRVs. Engagement of women as seed producers catalyses adoption. Arouna et al., 2019 conducted a randomized control experiment on the impact of contract farming in Benin and shows that contracts which only include an agreement on price have nearly as large of an impact as did contracts with additional attributes. This suggests that once price uncertainty is resolved, farmers are able to address constraints on their own. Seed and variety dissemination Roadmaps for seed	2019 - 50% of key regions have at least one functional multistakeholder platform or improved seed system at key action sites.	Complete	The Sustainable Rice Platform is operational across the globe with over 130 members from both public and private sector. Sustainable Rice Platform Standard and Performance Indicators 2.0 were released in January 2019. 1,000 farmers' rice cultivation practices were assessed using these tools in Burkina Faso, Ghana, Nigeria, Senegal, and Tanzania.	http://africarice.org/publications/AR2018/AfricaRice-AnnualReport-2018.pdf http://www.sustainablerice.org/Get-Involved/#members-list http://www.sustainablerice.org/

			dissemination were developed for a number of countries: Burkina Faso, Gambia, Guinea, Mali, Nigeria, Sierra Leone, Ethiopia, Uganda and Madagascar.				
	F1 Outcome: Effective networks and mechanisms to provide policy makers with up-to -date and evidence-based information on the rice sector	Enhanced individual capacity in partner research organizations through training and exchange	New approaches for policy engagement were tested and piloted in three countries (Papua New Guinea, Philippines, and Indonesia) with the ambition to show the usefulness of using policy oriented research outputs in policy processes to increase the influence of IRRI in policy circles. The policy engagement to develop a rice value chain in Papua New Guinea was interrupted after the first stakeholders workshop due to lack of funding commitment by DFAT to pursue the project. The IGRM models was also applied to the case of the Rice Tariffication in the Philippines to underpin early and future policy dialogue in late 2019 with the Department of Finance and Rice Traders. The policy engagement in The Philippines went reasonably well. However, by end of 2019, it was not clear whether IRRI's policy engagement could substantially influence the Philippines government thinking on the next steps of the Rice Tariffication. To support regional policy initiatives, AfricaRice is contributing to the development of the UEMOA/WAEMU Rice Agenda 2021-2030 aimed at boosted rice production in the region. The stakeholders included representatives from the Ministry of Agriculture in the 8 UEMOA member	2019 - At least 2 agrifood policies informed by recommendation from rice science are adopted in Asia, Africa and Latin America and Carribean	Extended	See the section 1.2, Table 2, on policies of this report. EG: Access to released varieties in ECOWAS member countries (all ECOWAS 15 countries are member of AfricaRice);Investment Policy for Rice Self-Sufficiency in The Gambia (CIPRiSSA-The Gambia); Policy for restructuring the Vietnamese rice sector	http://www.hubrural.org/PREMIERE-REUNION-DU-GROUPE-DE-TRAVAIL-POUR-L-ELABORATION-DE-L-AGENDA-RIZ-DE-L.html?lang=fr

			countries, AfricaRice, ECOWAS/Hub Rural, Regional Farmers' Organizations, JICA and UEMOA/WAEMU.				
	F1 Outcome: Impacts and adoption of RICE technologies assessed and published	Increase capacity of beneficiaries to adopt research outputs	The impact assessment study on stress-tolerant varieties was funded by SPIA. In partnership with Virginia Tech, CIAT conducted the impact assessment of CURE project in Vietnam and Nepal. Several adoption and impact assessment studies were conducted and published. Arouna et al., 2019 assessed the economic and environmental indicators of rice production in 6 African countries for irrigated and rainfed environments. Arouna Aboudou (2019) assessed the impact of drought-tolerant rice varieties (DTRV) in Benin, Madagascar and Nigeria and found that their adoption improved household food security. The adoption of DTRV boosted rice yield by 570 kg/ha (24% increase), leading to an increase in household income by US$ 126 per ha. The Impact Assessment of the International Rice Genebank (IRG) on Improved Rice Varieties in Eastern India revealed that 45–77% of the genetic composition of improved rice varieties comes from the genes of IRG accessions (Villanueva et al. 2019). Arouna (2019) assessed the impact of CARD and showed that over the period 2008-2018, rice production, harvested area and yield increased by 103%, 60% and 27%, respectively. CARD has an annual impact of 6.15 million ton of paddy rice, 1.65 million	2019 - Impact assessed of adoption of Alternate wetting and drying, Rice Crop Manager, and Rice Advice in Asia and Africa	Complete	Arouna et al. (2019) showed that adoption of RiceAdvice increased income by about $227. In Nigeria, its use had 15 % higher yields and 20 % higher profits. About 132,000 farmers in SE Asia adopted best management practices and increased their yield by 11-20%, and profit by 13-25%.	https://cals.arizona.edu/arec/sites/cals.arizona.edu.arec/files/publications/CRP-201902.pdf http://www.grisp.net/file_cabinet/files/984822/download/CORIGAP%202019%20Annual%20Progress%20Report.pdf?m=1585653806

			ha of additional area and 0.29 t/ha of yield increase.				
	F1 Outcome: Functional and effective results-based management system for RICE and its partners	Increased capacity for innovations in partner research organizations	The MELIAG workshop was organized in September 2019 to facilitate scientists' understanding and knowledge in using MARLO reporting and planning platform. The MELIAG workshop allows coordinating the reporting and reviewing of flagship progress on RICE milestones and indicators in the MARLO platform. The IOMEL strategy was developed and established as institutional system aimed at strengthening IRRI's relevance, effectiveness and accountability as RD organization. In the first year of implementing the strategy, the IEL Cluster undertook stocktaking of IRRI's impact evidence and reviewed the impact pathway of selected projects. The goal of the review is to document learning from successful/unsuccessful impact pathways and articulate them through IRRI institutional theory of change. Learning from the review conducted on AWD projects implemented in the Philippines are now compiled in a report for publication. Impact Evaluation of rice technologies has mostly been dominated by localized, small scale and project-driven studies. The IOMEL strategy emphasizes moving away from project approach to adopt programmatic approach and articulates an increased focus on policy advice and policy impact evaluation. A workshop was organized on	2019 - Impact and adoption reports; outcome stories; peer-reviewed publication research outcomes; learnings and adaptive implementation	Complete	See the evidence and OICR reports in this annual report of RICE 2019.	

			May 20-24, 2019, in Rome to build a community of practice around cutting-edge methodologies on monitoring, evaluation, as well as ex-post and ex-ante impact assessment.				
F2	F2 Outcome: Diversified enterprise opportunities through upgraded value chains at six action sites (Indonesia, Myanmar, Vietnam; Cote d'Ivoire, Nigeria, Tanzania)	Diversified enterprise opportunities	FP2 contributed to diversified enterprise opportunities by (i) generating market intelligence for gender-responsive product profiling, accelerated breeding, food choice, and women's empowerment, (ii) developing rice value chain upgrading strategies and sharing them at a regional multistakeholder workshop; (iii) developing and piloting several innovations in Asia (rice husk furnace, rice straw furnace, rice straw feed, rice straw mushroom, LCA-rice straw, rice straw pelleting, and rice straw batch biogas production); (iv) publishing several scientific articles and a Springer book on sustainable rice straw management; (v) standardizing several locally fabricated technologies (Mini-GEM system, Mini-ASI, Paddy cleaner, Rice grader and different rice husk gasifier stoves) with private sector and showcasing them at a major agricultural forum in Africa.	2019 - Upgrading strategies developed with partners for increasing value capture by actors in three action sites	Complete	Articles on market intelligence for gender-responsive product profiling, food choice, and women's empowerment. Articles on value chain upgrading strategies and a special issue on food systems. Springer book on intersectoral upgrading strategies for rice straw value chains. Two press releases on FP2's partner engagements.	Rice quality: How is it defined by consumers, industry, food scientists, and geneticists? What drives consumer demand for rice fragrance? Evidence from South and Southeast Asia https://www.semanticscholar.org/paper/Parboiling-as-a-diversification-strategy-to-improve-Fiamohe-Kinkpe/638cf94568c4d1cfd05eaef3efced7a39cb1ba27" style="font-size: 0.98em; background-color: rgb(255, 255, 255); (Parboiling as a diversification strategy to improve rice market value in Senegal) https://doi.org/10.1016/j.jrurstud.2019.09.002" style="font-size: 0.98em; background-color: rgb(255, 255, 255); (Off-farm employment increases women's empowerment: Evidence from rice farms in the Philippines)

							Inclusiveness of contract farming along the vertical coordination continuum: Evidence from the Vietnamese rice sector The modernization of the rice value chain in Senegal: A move towards the Asian Quiet Revolution? http://dx.doi.org/10.19182/agritrop/00098" style="font-size: 0.98em; background-color: rgb(255, 255, 255); (Risks of smallholder exclusion from upgrading food chains) https://sites.google.com/a/irri.org/social-sciences-division/project-updates/crowdinginprivatesectorinvestmentintheseedsectorevidencefromcambodianricevaluechains" style="font-size: 0.98em; background-color: rgb(255, 255, 255); (Crowding in private sector investment in the seed sector: Evidence from Cambodian rice value chains) https://link.springer.com/content/pdf/10.1007%2F978-3-030-32373-8.pdf" style="font-size: 0.98em; background-color: rgb(255,

							255, 255); (Sustainable rice straw management) Interdisciplinary CGIAR team contributes to accelerating rice value chain upgrading in Africa
				2019 - Upgrading strategies piloted with partners for verification in three action sites	Complete	Book with 11 chapters on piloting of sustainable rice straw management with partners and report on multistakeholder workshops on rice straw value chain upgrading in three countries. Press releases on scaling of rice straw management in Cambodia, multistakeholder workshop in Africa, and participation and poster at SARA 2019.	Sustainable rice straw management Report of the workshop series on building market prospects and value chain of rice straw in Vietnam, Cambodia, and the Philippines Cambodia scales up rice straw management Interdisciplinary CGIAR team contributes to accelerating rice value chain upgrading in Africa
	F2 Outcome: Income by value-chain actors increased by 10% at six action sites through improved access to financial and other services (Indonesia,	Improved access to financial and other services	FP2 has contributed to understanding the constraints and opportunities in value chain services and agricultural finance in Nigeria and Tanzania. It has supported three MSc students. By 2019, in Cambodia 162 students have graduated with a BSc in agricultural engineering from the Royal University of Agriculture RUA with 83 students being enrolled and 64 apprentices qualified as Agricultural machinery Mechanics from Don Bosco, Battambang, with 32 apprentices currently being enrolled. With the interventions of FP2 and related bilateral projects (e.g. BMZ rice straw and VnSAT), rice straw balers are rapidly adopted in MRD of Vietnam and	2019 - Rice market value captured by women scale-processors increased thanks to the improved parboiling system introduced for rice products diversification in Cote d'Ivoire.	Complete	Participation of the Bouaké innovation platform at SARA 2019 in Cote d'Ivoire. Paper on value of improved parboiled rice in Benin and Senegal. Report and two MSc theses on rice value chain upgrading in Cote d'Ivoire.	Impacting consumer valuation of improved local parboiled rice in Benin through video and rural radio Parboiling as a diversification strategy to improve rice market value in Senegal Potentiel de contractualisation dans l'agriculture rizicole en Côte d'Ivoire : Typologie, déterminants et modes de transaction Upgrading of the rice value chain in Cote d'Ivoire Participation of the Bouaké innovation platform

	Myanmar, Vietnam; Cote d'Ivoire, Nigeria, Tanzania)		Cambodia that lead to a value-adding of 5–10% to rice production. A Sustainable rice straw technology was adopted in Vietnam and Cambodia.				at SARA 2019
				2019 - Opportunities for youth engagement in agribusiness services provision identified along the rice value chain in Côte d'Ivoire.	Complete	New business model developed for attracting youth in agribusiness. Participation of the Bouaké innovation platform at SARA 2019 enabled capturing interest of youth in improved postharvest technologies. Annual graduate and student numbers and two press releases on involvement of value chain actors in sustainable rice straw management in Cambodia.	Modernizing postharvest operations services to attract youth in agribusiness: A new business model for policy actions Outcomes of RICE activities on strengthening Value Chain Support Services and Youth in Cambodia Cambodia scales up rice straw management Mekong Delta rice farmers earn big from selling straw Potentiel de contractualisation dans l'agriculture rizicole en Côte d'Ivoire : Typologie, déterminants et modes de transaction Upgrading of the rice value chain in Cote d'Ivoire Participation of the Bouaké innovation platform at SARA 2019
	F2 Outcome: Income by value-chain actors	Reduce pre- and post-harvest losses, including	FP2 has contributed to developed, adapted and piloted post-harvest technologies in Benin, Cote d'Ivoire and Nigeria. These technologies have contributed to post-harvest loss reduction, the production of	2019 - At least two loss reduction or value addition options identified and piloted	Complete	Several peer-review articles and AfricaRice Annual report demonstrating each of these post-harvest technologies. Independent reports from other developmental partners in rice value chain in Africa. Activities	Evaluation of fan-assisted rice husk fuelled gasifier cookstoves for application in sub-Sahara Africa https://taat-africa.org/scale-

	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)	those caused by climate change	quality products, time saving, increased revenue for value chain actor and reduction in pollution. These technologies include (i) coupling optimum harvesting time with mechanized threshing reduced harvesting loss by 23%, reduces drudgery and safes time; (ii) the GEM parboiling technology, which increases the nutritional and physical quality of rice, reduces drudgery, pollution and wood consumption, increases the value rice by $0.02 per Kg compared to rudimentary parboiled rice; (iii) rice husk gasifier stoves for parboiling and household cooking, resulting in 100% saving on the cost of wood for parboiling and cooking. An added advantage is that these stoves also reduce blackening of cooking pots and adds value to rice husk, a previously wasted resource. GrainSafe Dryer verification started with national partners in Myanmar (3), Sri Lanka (1), Cambodia (1), India (1), Philippines (2), VIetnam (1), Senegal (1), Thailand (1).			included in CORIGAP Annual Report and several press releases.	up-of-quality-gem-parboiled-rice-leads-to-increase-in-livelihood-opportunities-in-nigeria/" style="font-size: 0.98em; background-color: rgb(255, 255, 255); (Scale up of Quality GEM parboiled rice leads to increase in livelihood opportunities in Nigeria) http://www.grisp.net/file_cabinet/files/984822/download/CORIGAP%20Annual%20Progress%20Report%202019.pdf?m=1585653806" style="font-size: 0.98em; background-color: rgb(255, 255, 255); (CORIGAP-PRO: Closing Rice Yield Gaps in Asia 2019 Annual Report) Enhancing Iloilo's rice productivity through innovations on land leveling and rice straw management EasyHarvest: Improved Rice Harvesting Service Delivery with ICT-Enabled Actor Geolocation and Optimized Scheduling Ushering Vietnam towards a new rice revolution using best management practices
				2019 - Prototype improved			

	F2 Outcome: Functional value chains for improved processing and novel products from rice at six action sites (Bangladesh, Cambodia, Indonesia; Benin, Cote d'Ivoire, Nigeria)	Increased value capture by producers	FP2 has facilitated the creation of eight functional rice multi-stakeholder platforms, composed of microfinance institutions, seed suppliers, agro-input dealers, grain producers, production advisors, millers, aggregators/marketers, parboilers, consumers, equipment fabricators and policy makers. These platforms have been established in Benin, Cote d'Ivoire, Nigeria, Niger and Togo. These platforms have as the kin-pin the GEM parboiling facilities with links to other technologies such as improved varieties, RiceAdvice/GAP, ASI-threshing, improved milling and storage. This combination of tools and technologies has resulted in (i) high volume and variety of financial flow, (ii) increased knowledge transfer, product quality and better prices, and (iii) provision of embedded services as part of a contract. Scientific evidence and practical solutions for sustainable rice straw management developed under the projects were disseminated to beneficiaries. Development of rice straw management contributed to 10–20% reduction in rice straw burning in Vietnam (2016–2019); the scalable sustainable practices in Vietnam were also transferred to Cambodia and the Philippines through the learning alliance; cross-country training workshops and study tours. The achievements such as publications, proceedings, training materials, etc., have been shared with other organizations such as GIZ, CSAM, FAO, ILRI, ACIAR, agricultural agencies and institutions	processing and novel products developed and tested at six action sites	Complete	Videos and news reports from different countries. Solutions for rice straw: 4 innovations in MARLO; 11 book chapters; 2 scientific articles. Rice straw mushroom production was piloted, tested, and developed in Vietnam, Cambodia, Myanmar, and the Philippines. Technology of rice husk downdraft for paddy drying was provided to India, Myanmar, Indonesia, and the Philippines.	Rice Innovation Platform - GEM parboiling technology in Nigeria Innovation platform - GEM parboiling technology in Benin Scale up of Quality GEM parboiled rice leads to increase in livelihood opportunities in Nigeria An assessment of irrigated rice production energy efficiency and environmental footprint with in-field and off-field rice straw management practices Optimization of a downdraft furnace for rice straw-based heat generation Sustainable rice straw management IRRI Rice Straw website Rice straw project team wins the outstanding research and development award in the Los Baños science community Cambodia scales up rice straw management Engaging global partners for sustainable rice straw management

			in Vietnam, Cambodia, Philippines, Thailand, Myanmar, India, etc.				
	F2 Outcome: Capacity development needs among partner research organizations along the rice value chain identified	Increased capacity for innovations in partner research organizations	FP2 has contributed to increase the capacity of processors, equipment fabricators and students from different countries in West Africa: (i) about 3000 rice processors (90% women parboilers) trained on the production of quality parboiled rice using the GEM parboiler fueled with improved wood or rice husk stoves; (ii) private equipment fabricators trained on the standardized production of locally fabricated equipment. FP2 and related bilateral projects such as CORIGAP, ADSP, and VnSAT substantially contributed to enhanced capacity and knowledge of NARES on sustainable postharvest management practices such as flatbed drying, in-store drying, hermetic storage, rice husk furnace, rice straw management, etc.	2019 - Research initiatives with evidence of direct response to demand of stakeholders along the rice value chain at six action sites	Complete	Several PhD and MSc dissertations. Videos and news reports from different countries. Training materials on seed processing, drying, storage developed and updated. News releases on capacity building in NARES.	https://www.researchgate.net/publication/340333032_Farmers%27_Preference_for_Improvement_of_Rice_Straw_Management_in_Mekong_Delta_Vietnam?isFromSharing=1" style="font-size: 0.98em; background-color: rgb(255, 255, 255); (Farmers' preference for improvement of rice straw management in Mekong Delta, Vietnam) Contribution of contract farming to sustainable rice value chain upgrading in the Mekong River Delta in Vietnam Crowding in private sector investment in the seed sector: Evidence from Cambodian rice value chains https://www.youtube.com/watch?v=PrGLv2IH_Y0" style="font-size: 0.98em; background-color: rgb(255, 255, 255); (AfDB seeks self-sufficiency in rice production in Africa through technologies) Scale up of Quality GEM parboiled rice leads to increase in livelihood opportunities in

							Nigeria Farmers and partners in Myanmar learn about improved rice straw mushroom production Mechanized rice straw collection training in Myanmar enhances gender equality on sustainable rice straw management Mindanao farmers learn about sustainable straw management from RiceStrawPH Interdisciplinary CGIAR team contributes to accelerating rice value chain upgrading in Africa Conference highlights need for increased climate funding for rice agri-food systems
F3	F3 Outcome: Improved management practices that reduce yield gap by 10-15% developed and disseminated at eight action sites (Nigeria,	Closed yield gaps through improved agronomic and animal husbandry practices	Introduction of technical innovations developed in RICE has shown yield increase in Benin, Brazil, India, Madagascar, Nigeria, Tanzania, Togo, Uganda, and Vietnam. The following are key highlights: - Randomized control trial in northern Nigeria showed that use of RiceAdvice had 15 % higher yields and 20 % higher profits. - On-farm trial in Tanzania showed that P micro-dosing increased grain yield of dry-seeded, dibbled rice by 26%. - Compared to the farmers' own practices, yield increases of 1 to 2.7 t/ha were achieved when following GAP in Tanzania.	2019 - Male and female farmers participating in demonstration reduce rice yield gaps by 10-15% at six action sites	Complete	Introduction of technical innovations developed in RICE CRP has shown 10% yield increase in 8 countries including Benin, Brazil, India, Madagascar, Nigeria, Tanzania, Togo, Uganda, and Vietnam.	https://cals.arizona.edu/arec/sites/cals.arizona.edu.arec/files/publications/CRP-201902.pdf https://www.sciencedirect.com/science/article/abs/pii/S0378429017317252 https://link.springer.com/article/10.1007/s10333-018-0666-7 https://link.springer.com/chapter/10.1007%2F978-3-319-77878-5_11 https://www.sciencedirect.c

	Senegal, Tanzania, Madagascar, Vietnam, Indonesia, Bangladesh, Myanmar)		- Adoption of smart-valley increased yield by 0.9 t/ha in Benin and Togo. - Introduction of Good Agricultural Practices in Madagascar increased the yield from 2.2 t/ha to 3.2 t/ha in uplands, and from 4.1 t/ha to 7.5 t/ha in irrigated lowlands. In Uganda, GAP increased the yield from 3 t/ha to 6 t/ha under irrigated lowlands. - In Brazil, The Latin American Fund for Irrigated Rice (FLAR) demonstrated 19% yield increase with introduction of improved management practices. - In Vietnam, introduction of labor-saving technologies together with 1 Must do and 5 Reductions increased rice yield by 10%. - In India, use of Rice Crop Manager had higher yield than farmers' practices.				om/science/article/pii/S0378429019301935 http://www.grisp.net/file_cabinet/folders/271907 (name: AfricaRice progress report for FP3 milestone 2019) http://www.grisp.net/file_cabinet/files/982009/download/Relatorio%20Final%20P10+.pdf?m=1584022400 http://www.grisp.net/file_cabinet/files/983611/download/SFLF%20Impacts%20Vietnam,%20LCA-two%20seasons,%20Nov%202019.pdf?m=1584959293
	F3 Outcome: Improved management practices that increase input use efficiency by 5% developed and disseminated at eight action sites (Nigeria, Senegal,	More efficient use of inputs	Sustainable Rice Platform Performance indicators (v2) were released in Jan 2019. IRRI and AfricaRice contributed to this revision. Some of indicators related to input use efficiencies were assessed for improved practices in sub-Saharan Africa (as review), and 7 countries including Benin, Côte d'Ivoire, Madagascar, Senegal, Tanzania, and Vietnam. - Agronomic efficiency of Phosphorus micro-dosing was assessed in Benin and Tanzania. - Water productivity and nitrogen use efficiency of alternate wetting and drying with different N fertilizer levels were assessed in Senegal. - N use efficiency for rice production in sub-Saharan Africa were reviewed.	2019 - Input use efficiency of improved practices assessed using sustainability indicators revised together with the Sustainable Rice Platform	Complete	Performance indicators related to input use efficiencies were assessed for improved practices in sub-Saharan Africa (as review), and 7 countries including Benin, Côte d'Ivoire, Madagascar, Senegal, Tanzania, and Vietnam.	http://www.sustainablerice.org/Resources/ https://www.sciencedirect.com/science/article/abs/pii/S0378429017317252 https://www.mdpi.com/2073-4441/10/6/711 https://www.tandfonline.com/doi/full/10.1080/1343943X.2019.1617638 http://www.grisp.net/file_cabinet/files/981725/download/Flagship%203%20report_FLAR.docx?m=1583954802 http://www.grisp.net/file_cabinet/files/978910/download/Assessment%20of%20nutrient%2

	Tanzania, Madagascar, Vietnam, Indonesia, Bangladesh, Myanmar)		- On-farm demonstration showed that Alternate wetting and drying (AWD) increased water productivity by 20% without yield penalty in Côte d'Ivoire. - N and P use efficiencies were assessed in long-term trial in Senegal. - Introduction of labor-saving technologies together with 1M5R in "Small farmers, large field" in Vietnam reduced seed rate by 45 kg/ha and pesticide use by 50%, and increased rice yield by 10%, resulting in an increase in farmer income by 20-30%. - In central highlands of Madagascar, A prototype of WeRise was developed and piloted in 80 farmers' fields in 2019-2020 wet season to assess its impact on yield and fertilizer use efficiency.				0use%20efficiency%20in%20long-term%20fertilizer%20trial%20in%20Senegal.docx.pdf?m=1581593066 http://www.grisp.net/file_cabinet/files/984628/download/JIRCAS%202019%20Progress%20Report%20for%20FP3,%20WeRise%20in%20Madagascar.pdf?m=1585531371 http://www.grisp.net/file_cabinet/files/983611/download/SFLF%20Impacts%20Vitenam,%20LCA-two%20seasons,%20Nov%202019.pdf?m=1584959293 http://www.grisp.net/file_cabinet/files/979024/download/AfricaRice%20progress%20report%20for%20FP3%20milestones%202019.pdf?m=1581690765
	F3 Outcome: Options to diversity rice farms with other crops, animals, or trees developed and	Increased livelihood opportunities	Farm diversification studies were conducted in 6 countries. Following are major progress: - Water productivity and profit of four off-season vegetable crops and their residual effect on rice was assessed in farmers' fields in Côte d'Ivoire. - Environmental sustainability (soil, weeds, pests), resilience to climate change, and productivity of different upland cropping systems were assessed in Côte d'Ivoire. - Phenology and productivity of 52 crop-	2019 - Multidimensional benefits from promising diversification options quantified with participation of male and female farmers and other value chain actors at four action sites	Complete	Farm diversification studies were conducted in 6 countries including Bangladesh, Côte d'Ivoire, Madagascar, Myanmar, and Senegal to assess impact of the farm diversification options on multidimensional benefits.	https://link.springer.com/article/10.1007/s13593-020-0612-0 https://agritrop.cirad.fr/595340/1/ABSTRACT_icropm20_Ranaivoson_et_al_.pdf http://agritrop.cirad.fr/593391/ https://link.springer.com/article/10.1007/s10333-019-00785-4

	disseminated at six action sites (Cote d?Ivoire, Madagascar, Tanzania, India, Bangladesh, Myanmar) (together with other CRPs)		variety combinations were assessed in Senegal. 50 farmers including 31 female farmers were invited to evaluate them in a field day. - Phenology and productivity of 14 rice-vegetable/legume combinations (12 vegetable and legume spp.) and their residual effect on rice were assessed in Madagascar. - *Stylosanthes guianensis* showed superior P uptake by 10- to 26- fold relative to the other major crops (rice, maize, and soybean) in Madagascar. - Multiple-purpose services in diversifying upland rice-based cropping systems, including protein supply for human and livestock as well as market (pulses), pest control, nutrient supply to soils, and rice productivity enhancement were assessed in Madagascar. - Potential benefits of rice-fish systems were reviewed for Myanmar. - Community water management, new rice varieties, and diversification options increased agricultural production in the polders of the coastal zone of Bangladesh.				https://www.researchgate.net/profile/Michael_Akester2/publication/334970226_Integrating_fish_into_irrigation_infrastructure_projects_in_Myanmar_rice-fish_what_if/links/5d74913992851cacdb2942c1/Integrating-fish-into-irrigation-infrastructure-projects-in-Myanmar-rice-fish-what-if.pdf http://www.grisp.net/file_cabinet/files/983611/download/SFLF%20Impacts%20Vitenam,%20LCA-two%20seasons,%20Nov%202019.pdf?m=1584959293 http://www.grisp.net/file_cabinet/files/984627/download/JIRCAS%202019%20Progress%20Report%20for%20FP3,%20P-efficient%20farming%20system%20in%20Madagascar.pdf?m=1585531367 http://www.grisp.net/file_cabinet/files/979024/download/Africa Rice%20progress%20report%20for%20FP3%20milestones%202019.pdf?m=1581690765 http://www.grisp.net/file_cabinet/files/978227/download/Field%20day%20report%20on%20farm%20diversification%20in%20Senegal

							%202019-2020.pdf?m=1581233735
	F3 Outcome: Diversified on-farm diets sourced through diversified farming systems at four action sites (Cote d?Ivoire, Madagascar, Bangladesh, Myanmar) (together with other CRPs)	Increased access to diverse nutrient-rich foods	2019 milestone was changed to "Linkage of farm diversification with on-farm diet diversity assessed, and strategies developed to enhance on-farm diet diversity through diversification" in POBW 2019, that was not reflected in MALRO system. - On-farm survey for assessing linkage of farm diversification with on-farm diet diversity was initiated in Nigeria, Rwanda, and Senegal. Preliminary analysis in Rwanda found positive relationships between diversification and nutritional outcomes. Thus, development and dissemination of crop diversification options including vegetables and legumes might be an effective strategy for diversifying farmers' diets thereby contributing significantly to improved nutrition. - Adaptive research on diversified cropping system in Bangladesh- Improvement in household nutrition due to the introduction of biofortified zinc rice, sunflower, and maize. Sunflower, as a dry season crop, is gaining popularity not only for its resilience but also its high acceptance as edible oil from the farmers' own farm. The community used maize grains and leaves as the feed for their poultry, livestock, and fish leading to households having more access to milk, meat, egg, and fish that can help improve the nutrition of the polder communities.	2019 - Baseline on-farm diets characterized at three action sites (Madagascar, Bangladesh, Myanmar)	Complete	Research on linkage between farm diversification and on-farm diets were conducted in four countries in Bangladesh, Nigeria, Rwanda, and Senegal. Project reports are available in below links.	http://www.grisp.net/file_cabinet/folders/271907 (name: AfricaRice progress report for FP3 milestone 2019) http://www.grisp.net/file_cabinet/files/983611/download/SFLF%20Impacts%20Vietnam,%20LCA-two%20seasons,%20Nov%202019.pdf?m=1584959293

	F3 Outcome: Improved rice management practices that reduce GHG by 5% disseminated at three action sites (Bangladesh, Philippines, Vietnam)	Reduced net greenhouse gas emissions from agriculture, forests and other forms of land-use (More sustainably managed agro-ecosystems)	Impact of crop management practices on GHG emissions assessed in three key action sites consisting of (i) Eastern India, (ii) Mekong delta, Vietnam, and (iii) northern Vietnam.- On-farm assessment of different rice crop management practices in the Mekong Delta, Vietnam showed that improved - practices including alternate wetting and drying (AWD) water management reduced GHG emissions by 39%.- IRRI and its partners assessed crop establishment methods in rice production systems of Eastern India. Direct seeded rice reduced GHG emissions by 17% in comparison with conventional transplanting. In northern Vietnam, on-farm experiments showed early plus midseason drainage reduced GWP by 42–66% than continuous flooding.	2019 - Demonstration farmers reduce GHG emission by 10-30% at three action sites	Complete	Improved crop and water management practices reduced GHG emission by at least 17% at three action sites.	https://www.sciencedirect.com/science/article/abs/pii/S0378429018300868?via%3Dihub https://www.sciencedirect.com/science/article/pii/S0959652619337059 https://www.sciencedirect.com/science/article/pii/S0167880917303614
	F3 Outcome: Results of completed farming systems analyses used to focus development activities on key opportunities for adapting to	Enhanced capacity to deal with climatic risks and extremes (Mitigation and adaptation achieved)	2019 milestone was changed to “In collaboration with the Sustainable Rice Platform, multidimensional sustainability indicators validated at four action sites” in POBW 2019, that was not reflected in MALRO system. - Data on performance indicators for sustainable rice cultivation were collected and analyzed from seven Asian countries Vietnam, Thailand, India, Indonesia, Myanmar, Sri Lanka, and China. - In Africa, data on Sustainable Rice Platform Standard/Performance Indicators were collected in Burkina Faso, Ghana, Nigeria, Senegal, and Tanzania, and key intervention	2019 - Integration of options for reducing risks caused by climate risks communicated to national policy framework (with FP1)	Complete	Data on performance indicators for sustainable rice cultivation were collected and analyzed from seven Asian countries and five African countries.	https://www.sciencedirect.com/science/article/abs/pii/S1470160X19303747 https://www.sciencedirect.com/science/article/pii/S0959652619337059 http://africarice.org/publications/AR2018/AfricaRice-AnnualReport-2018.pdf http://www.grisp.net/file_cabinet/folders/271907 (name: Survey Solution Manual)

	climate risks at eight action sites (Nigeria, Senegal, Tanzania, Madagascar, Vietnam, Indonesia, Bangladesh, Myanmar)		areas for improving sustainable rice cultivation were identified. Data collection tool for Sustainable Rice Platform Standard/Performance Indicators were developed using Survey Solutions, and data collection was initiated in Côte d'Ivoire, Nigeria, and Senegal.				
	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,	Technologies that reduce women`s labor and energy expenditure adopted	2019 milestone was changed to "two action sites" only in POBW 2019, that was not reflected in MALRO system. Following is major progress in this outcome. - Motorized weeder and drum seeder were tested in Côte d'Ivoire. - Prototype fertiseeder was developed and tested. The fertiseeder was modified based on the suggestions of the farmers and tested in Madagascar. - In Vietnam and Cambodia, laser leveling has been extensively demonstrated and services are provided by government institution. - Women entrepreneurs in agricultural mechanization was developed in Bangladesh. The landless poor who used to harvest paddy manually were provided services on harvesting paddy by reaper leading to improved livelihoods with higher income (USD392-503 per year) than before	2019 - Prototype labor-saving technologies for crop establishment and weeding, harvesting, and threshing introduced for testing at seven action sites	Complete	Prototype labor-saving technologies were tested in three Asian and two African countries.	http://www.grisp.net/file_cabinet/folders/271907 (name: AfricaRice progress report for FP3 milestone 2019) http://www.grisp.net/file_cabinet/folders/271907?page=1 http://www.grisp.net/file_cabinet/files/983610/download/Laser%20Leveling%20in%20Vietnam,%202017,%20Dec.,%20Hung,%20VnSAT.pdf?m=1584958889 http://www.grisp.net/file_cabinet/files/983608/download/Laser%20Leveling%20in%20Cambodia%202019,%20G.%20Hitzler.pdf?m=1584945100 http://www.grisp.net/file_cabinet/files/983607/downlo

	Indonesia, Bangladesh, Myanmar)		(USD45-114 per year).				ad/Laser%20Land%20Leveling%20in%20Cambodia,%20CAVAC%20%202019.pdf?m=1584944892 http://www.grisp.net/file_cabinet/files/983611/download/SFLF%20Impacts%20Vietnam,%20LCA-two%20seasons,%20Nov%202019.pdf?m=1584959293
	F3 Outcome: Increased capacity for innovation on sustainable farming systems in partner research organizations	Increased capacity for innovations in partner research organizations	This outcome was removed from FP3 two years ago but still features in MARLO. We'll try to remove it again in 2020.	2019 - Research initiatives on sustainable farming systems with evidence of direct response to demand of stakeholders	Cancelled	This milestone was removed from FP3 two years ago but still features in MARLO. We'll try to remove it again in 2020.	NA
F4	F4 Outcome: Predicted global rice production risks used to guide development and targeting of climate	Enhanced adaptive capacity to climate risks (More sustainably managed agro-ecosystems)	For the year 2019, progress was achieved toward this outcome by establishing 28 Antennae panel (AP) and 13 Reference panel (RP) sites with the global Rice Array phenotyping network by all contributing centers: IRRI, CIAT, CIRAD, AfricaRice, covering various sites in the 3 continents. Also, 48 datasets from 27 different sites including soil/climate data were curated and annotated (this is a 70% of the sites). Additionally, the 3000 rice genome	2019 - Antenna experiments have generated quality data (environment and crop) from at least 80% of the global array sites	Extended	Defined array and reference panels; first panels grown at platform sites. From this and other milestones, it can be evidenced that the panels have been trialed and data collection has been ongoing from various sites.	https://sites.google.com/a/irri.org/demo-fp4-gra/info-on-panels/data-from-ap-rp-trials https://drive.google.com/drive/folders/1M6CABVCwoxYKtBGVyD8isofHPzjLek6j

	change-adapted technologies at least for the most vulnerable rice agroecosystems		metadata was used to identify genomic regions that affect community assembly for Phytobiomes. Some delays and funding constraints delayed trials at sites in China and grain quality analyses for trials from three Philippine and one Myanmar site were planned but could not be done. Change of staff and some adverse climatic conditions affected establishing trials in some sites. But we are actively finding new partners and trial sites for GRA.				
	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 climate-	Adoption of CGIAR materials with enhanced genetic gains	Progress toward this outcome was through Drone-based high-throughput phenotyping (HTP) platforms in various centers and locations. It was conducted for the antennae panel in Philippines, India, Colombia, and Cote d'Ivoire. Also, image processing and HTP+manual data was collated at IRRI and CIAT. CIAT also continued work on the Pheno i platform, that integrates drone and satellite images. Plant phenotyping capacities were upgraded in Cote d'Ivoire and Senegal by rehabilitating field sites for the evaluation of Fe-toxicity and salinity. A drone-based phenotyping platform were established to monitor field trials in Cote d'Ivoire and Senegal), as well as hardware equipment for image-data storage, processing and analysis at AfricaRice. Establishing drone-based phenotyping at 2 locations in India (Titabar and Maruteru) was unsuccessful due to reduced staff and partner interest. Training workshops and visits to partner sites were	2019 - (i) Phenotyping facilities and network up and running in at least 60% of the target sites, (ii) new HTP platforms established at Mbé (HTP field-based), CIAT PALMIRA, and IRRI, (iii) Efficient reporting (data acquisition, quality control, annual reports, etc.) mechanisms/tools are in place mechanisms/tools are in place	Extended	Existence of phenotyping platforms, phenotype genotype protocols available, data available for multiple sites, reports.	https://drive.google.com/open?id=0B8jTKxo5A2KUaGVjUHFzVUVCM2M

	smart rice varieties		not possible due to lack of funding. Delays in hardware acquisition continued to stall image processing and field surveying activities by other partners. Use of drone in Cote d'Ivoire was hampered by bird attacks.				
				2019 - Phenotyping facilities and network up and running in all initial target sites and new partners interested in	Complete	Phenotyping facilities and network up and running, new High Throughput Phenotyping platforms established, efficient reporting and mechanisms/tools are in place. Innovations with links reported in this AR19 (Image controlled vocabulary, image drone database). Courses in drone use for agriculture available in IRRI Education.	https://ciat.cgiar.org/phenomics-platform/phenoi/ http://education.irri.org/short-courses/technology-transfer/agricultural-drones-digital-mapping https://drive.google.com/open?id=0B8jTKxo5A2KUaGVjUHFzVUVCM2M
	F4 Outcome: Characterized pathogens populations and diversity used to predict varietal deployment for at least 3 major rice diseases	Enhanced capacity to deal with climatic risks and extremes (Mitigation and adaptation achieved)	Some tools were developed to be able to diagnose various pests and diseases. Additionally, research advances brought new information that will contribute to tackling others. For example, a new diagnostic multiplex PCR assay was refined using AfricaRice's strains collection, together with partners. Pathotracer continued with the input of new data and the portal is ready for testing. Pathotracer involves a network of NAREs in-charge of sampling and monitoring the results. In 2019, 10 institutes in 7 countries began using Pathotracer and will generate feedback necessary for scaling up in the future. Another development was new data collection from trials and site testing, new allele discovery and tolerant varieties were discovered, activities that advanced	2019 - Field diagnostic tools developed for epidemiology surveys	Complete	A new diagnostic multiplex Polymerase Chain Reaction assay was refined using AfricaRice's strains collection with private partners to potentially discriminate multiple pathogens. Pathotracer is being tested by partners to improve performance and get it ready for uptake.	https://s3-ap-southeast-1.amazonaws.com/pathotracer.irri.org/app/index.html

			research on Blast, Rice Yellow mottle virus (RYMV), Rice Stripe Necrosis Virus, Pantoea blights and Bacterial leaf blight. PhD students and on-the-job trainees were involved in the rice array data curation and analyses and a PhD from AfricaRice visited China to develop her skills to identify blast resistance genes. The loss of AfricaRice's pathologist in mid-2019 has affected continuation of activities.				
	F4 Outcome: A functional rice data hub providing open access phenotypic and genotypic information and data analysis tools for users worldwide	Increased conservation and use of genetic resources	For this outcome, in 2019 48 datasets of phenotypic and genotypic data from the Antennae Panel and Reference Panel were curated. This data was made available from 27 sites, distributed in 3 continents. Additionally, data from various sites was corrected for spatial effects using experimental design and climate data.	2019 - Development of the rice data hub completed for data curation and integration modules (at least version 1)	Extended	Existence of data gathering, sharing and analysis tools: phenotype and genotype analysis platforms available, reports.	https://sites.google.com/a/irri.org/demo-fp4-gra/info-on-panels/data-from-ap-rp-trials https://drive.google.com/drive/folders/1M6CABVCwoxYKtBGVyD8isofHPzjLek6j
	F4 Outcome: Increased capacity for innovation in pre-breeding and Big	Increased capacity for innovations in partner research organizations	The Rice Functional Genomics and Breeding (RFGB) database v2.0 was updated with improved functionality over the previous database. The latest version includes new features that allow the uploading of genotypic data and the linking of the genotyped line directly to seed accessions in the genebank to place a seed request. This	2019 - Research initiatives in multi-environment prebreeding and Big Data feeding into rice breeding pipelines	Complete	Reports and publications as per references below.	http://www.rmbreeding.cn/Index/ http://www.rmbreeding.cn/snp3k https://onlinelibrary.wiley.com/doi/full/10.1111/pbi.13215 https://onlinelibrary.wiley.com/doi/full/10.1111/pbi.13215#pbi13215-bib-

	Data in partner research organizations		database is used by researchers (for example breeders or molecular biologists) and other partners that work in the improvement of varieties. Also, genotype by environment (G x E) imputation was implemented and GWAS tools were deployed in Rice Galaxy.				0009 https://onlinelibrary.wiley.com/doi/full/10.1111/pbi.13215#pbi13215-bib-0005 https://marlo.cgiar.org/projects/BigData/studySummary.do?studyID=3181cycle=Reportingyear=2019 https://galaxyproject.org/use/rice-galaxy/
F5	F5 Outcome: Rice diversity in rice gene banks used globally for identification of traits and discovery of new genes	Increased conservation and use of genetic resources	In CoA 5.1 (Harnessing genetic diversity), screening and validation experiments using germplasm panels and populations resulted in the discovery of novel donors and genomic regions associated with anaerobic germination (AG), stagnant flooding (SF), grain Zn content, sheath blight tolerance, and drought/direct seeded rice (DSR). Several publications are nearing submission. From a DSR trial, 50 potential donors have been selected for gap analysis with DST elite lines and a Backcross isogennic line (BIL) (*rufipogon x indica*) was selected for use in the stress breeding program.	2019 - 25% of targeted traits/donors/QTLs/genes identification achieved. 100% of the diversity analysis accessions sequenced	Complete	Identified donors and genomic regions associated with anaerobic germination, stagnant flooding, grain zinc and drought/direct seeded rice for 25% of the targets. Over 50% of the donors are from sequenced panels of germplasm (3K rice genomes and Aus panel). The use of these panels is reported to the Genebank Platform. Screened 250 accessions from the 3K panel for grain Zn concentrations and identified 2 potential new donors combining above-average yield with grain Zn concentrations 35 ppm. Developed genomic prediction (GP) model to estimate accessions grain Zn concentrations among the 3K accessions. •Identified a new sets of SNP markers diagnostic in *indica x aus* and *japonica x aus* breeding populations through GBS.	https://doi.org/10.2135/cropsci2018.08.0526 https://doi.org/10.1093/aob/mcz118 https://onlinelibrary.wiley.com/doi/abs/10.1111/pbi.13334 https://doi.org/10.1101/gr.241240.118 https://www.biorxiv.org/content/10.1101/658237v1 doi.org/10.1016/j.jplph.2019.152998 https://doi.org/10.3390/plants8100376 https://doi.org/10.1093/gbe/evz084 https://doi.org/10.1186/s12284-019-0281-2
	F5 Outcome: New rice varieties resulting in 1.3 % genetic gain	Adoption of CGIAR materials with enhanced genetic	Mid 2019, we organized a workshop with contributions from the Excellence in Breeding platform to adapt our objectives and workplans to emerging insights on modernization of breeding programs, and to take into account the lessons learned from developing the 'Crops to end hunger'	2019 - 60 lines nominated for release with 15% higher yield and meeting national quality requirements	Changed	Genetic gain for IRRI irrigated program estimated to be 5-12 k/ha/year and 45-40 k/ha/cycle. gBLUPs (Breeding values based on genomic selection) generated for thousands of lines across Asia and Africa. RUDhan1 and NSICRc580 released in Bangladesh and Philippines respectively. Near isogenic	https://doi.org/10.20900/cbgg20190008 https://doi.org/10.1016/bs.agron.2019.05.001 https://doi.org/10.2135/cropsci2018.09.0537 https://doi.org/10.1007/s00122-018-3266-

	in intensive systems	gains	initiative. As a result, the original milestone (60 lines nominated for release with 15% higher yield and meeting national quality requirements) was changed into: Baseline genetic gain values established for major breeding sub programs. Genomic selection initiated; 20 10 lines nominated for release with 10 5% higher yield, and meeting national quality requirements, in intensive systems.FP5.3 (Intensive Systems) continued its march to produce high yielding breeding material and release it across target geographies. Thousands of new breeding lines were generated and hundreds of more advanced lines were tested and advanced towards variety release at IRRI, CIAT, and AfricaRice. Eight types of trials were sent to 15 countries, and included types were for Irrigated, Rainfed, Upland topographical types, abiotic stresses such as cold tolerance, salinity and flood tolerance, pest and disease tolerances for Blast, Brown Plant Hopper and bacterial blight. For MET trials data has been analysed for dry season and shared with all the collaborators.			lines(NILs) for true blast resistance genes, Pii, Pi3, Pik, Pik-h, Pikp, Pi1, Pi7(t), Piz, Piz-5, Pi9(t), Pi12(t), Pish, were developed, and confirmed the genetic improvement of resistant by inoculation test with international standard differential blast isolates. To develop NILs for partial resistance genes (pi21 and PB1), hybrid populations (BC5F2 and BC6F2) were generated, and homozygote plants will be selected in 2020. The effect of actpk1 (loss-of-functional type of negative regulator for nitrogen uptake) were confirmed in the *indica* genetic background (IR64 and Sahel108). NILs (5 each in the IR 64 and Sahel108) were selected by whole genome survey.	4 https://doi.org/10.1007/978-3-319-77878-5_6 https://doi.org/10.1371/journal.pone.0210529
	F5 Outcome: Rice varieties with 20, 15, 10% reduction in yield loss	Enhanced capacity to deal with climatic risks and extremes (Mitigation and	Mid 2019, we organized a workshop with contributions from the Excellence in Breeding platform to adapt our objectives and workplans to emerging insights on modernization of breeding programs, and to take into account the lessons learned from developing the 'Crops to end hunger' initiative. As a result, the original milestone	2019 - Genes confering tolerance of two of the relevant stresses in the three ecosystems combined in elite backgrounds initial elite lines nominated for release	Changed	Standardized Rapid Generation Advancement - Line Stage Testing based genomic breeding pipeline. Rainfed Core Breeding Panel (RCP) (1.0) characterized and genotyped. Frequency of major genes determined.. Direct Seeded Rice program initiated and first version of the core panel constituted. Breeding lines for lowland systems (8 lines)	Turning to rice cultivars for solving the methane emissions in irrigated systems https://flar.org/resolviendo-el-rompecabezas-de-las-emisiones-de-gases-de-efecto-invernadero-en-el-cultivo-del-

	caused by factors induced by climate change, in mega deltas, rainfed lowlands, and uplands, respectively	adaptation achieved)	(Genes conferring tolerance of two of the relevant stresses in the three ecosystems combined in elite backgrounds initial elite lines nominated for release) was changed into: Baseline genetic gain values established for major breeding sub programs. Breeding panel evaluated to initiate genomic selection. Multiple breeding lines were nominated in release pipelines or released as new varieties for countries in South and South East Asia. Some of these include IR10F365 and IR13F265 for flood prone areas in Philippines; IR13F115 and IR12F578 for flood prone areas in Nepal, Bahuguni dhan 1 and 2 for flood and drought prone areas in Nepal and Inpari 46 for rainfed lowland drought and coastal saline regions in Indonesia. IR13F265 is identified for release in the Philippines. A focused breeding program for direct seeded rice is now operational at IRRI HQ. The rainfed breeding program is steadily moving towards the Rapid Generation Advancement breeding method.			and upland systems (6 lines) submitted for variety registration trials in Madagascar. 30 breeding lines evaluated under low-input conditions in the hilly region of Nepal. New donors with tolerance to Fe toxicity identified in Madagascar.	arroz/ doi.org/10.1016/j.jplph.2019.152998 https://doi.org/10.1016/B978-0-12-814332-2.00011-3 https://doi.org/10.3389/fpls.2019.00159 https://doi.org/10.1186/s12284-019-0269-y https://doi.org/10.1016/j.wdp.2019.100131
	F5 Outcome: High quality and high nutritious rice varieties that are preferred	Increased access to diverse nutrient-rich foods	Mainstreaming Zn in irrigated breeding targets was initiated. Zn content in the grain is a critical micronutrient for human nutrition and has been progressed by identifying several new donors (Jamir, UCP222) from the *aus* types that have much higher levels of zinc and increased iron in the grain. GWAS identified peaks on Chr5, 7 9. Populations have been developed and	2019 - Nutritious rice with 20-22 ppm Zinc content	Complete	qZn QTL on chromosome 5 identified to confer high zinc in milled rice samples. Using traditional method, Zn levels were enhanced in the range between 19-24 ppm and several varieties (BRRI Dhan 62, BRRI Dhan 64, BRRI Dhan 72 and BRRI Dhan 74) have been released meeting the target criteria.	https://doi.org/10.1007/978-3-319-95354-0_1 https://www.sciencedirect.com/science/article/abs/pii/S0378429018317167 https://doi.org/10.1007/978-1-4939-8914-0_2 https://doi.org/10.1007/978-1-4939-8914-

	by men and women farmers and consumers		QTL validated. Common QTL on chromosome 5 was identified consistently across different mapping populations. Several of the high Zn rice varieties with up to 16 ppm have been released in Bangladesh and Indonesia. Pre-breeding for lowered glycemic index with acceptable texture was initiated. Reliably generating rice varieties with low glycemic index (GI) is an important nutritional intervention given the high rates of Type II diabetes incidences in Asia where rice is staple diet. We integrated a genome-wide association study (GWAS) with a transcriptome-wide association study (TWAS) to determine the genetic basis of the GI in rice. GWAS utilized 305 re-sequenced diverse *indica* panel comprising ~2.4 million single nucleotide polymorphisms (SNPs) enriched in genic regions. A novel association signal was detected at a synonymous SNP in exon 2 of LOC_Os05g03600 for intermediate-to-high GI phenotypic variation.				0_13 https://doi.org/10.1007/978-1-4939-8914-0_14 https://doi.org/10.1016/j.fcr.2019.01.011 https://doi.org/10.1007/s10681-019-2384-7 https://doi.org/10.1016/j.jcs.2019.02.001 https://doi.org/10.1016/j.cj.2019.03.002 https://doi.org/10.1038/s41598-019-43888-y https://doi.org/10.3177/jnsv.65.s26 https://doi.org/10.3177/jnsv.65.s48
	F5 Outcome: Increased capacity on modern rice breeding technologies in partner research organizatio	Increased capacity for innovation in partner development organizations and in poor and vulnerable communitie	Mid 2019, we organized a workshop with contributions from the Excellence in Breeding platform to adapt our objectives and workplans to emerging insights on modernization of breeding programs, and to take into account the lessons learned from developing the 'Crops to end hunger' initiative. As a result, the original milestone (Research initiatives on modern rice breeding technologies with evidence of direct response to demand of rice value	2019 - Research initiatives on modern rice breeding technologies with evidence of direct response to demand of rice value chain stakeholders	Changed	Standard Operation Procedures (SOP) for B4R task management and data collection was created and authorized. SOP's were implemented and the monitoring of compliance started at IRRI headquarters and in Easter Southern Africa region. SOP creation for experiment creation and harvest data management was started.	https://doi.org/10.20900/cbgg20190008 https://doi.org/10.1016/bs.agron.2019.05.001 https://doi.org/10.1007/s00122-019-03317-0 https://doi.org/10.1016/j.dib.2019.103782 https://doi.org/10.1126/science.aav6316 https://doi.org/10.2135/cropsci2018.09.0537

	ns	s	chain stakeholders) was changed into: Standardized design and data collection management as well as defined standard operating procedures and mechanization for field trials. In FP 5.6 (Modernizing rice breeding), Breeding4Rice is now part of the Enterprise Breeding System. The system enables the use of standardized experiment designs and facilitates the usage via workflow. The use of standardized trial experiment models in experimental design allows the development and implementation of semi-automatic experiment data analysis. During the year the design of the workflow and models was completed. The development and implementation of the analysis workflows will be completed by the end of Q2 2020. The analysis workflow is fully aligned with the Unified Breeding Strategy that was created during 2019 at IRRI Rice Breeding Platform.				

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

	Number	Percent
Peer-Reviewed publications	312	100.0%
Open Access	273	58.97%
ISI	185	87.82%

Table 7: Participants in CapDev Activities

Number of trainees	Female	Male
In short-term programs facilitated by CRP/PTF	11994	23359
In long-term programs facilitated by CRP/PTF	224	243
PhDs	61	71

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 partnership with University of Arizona on impact assessment has been very beneficial. With this partnership RICE effectively responded to calls launched by the CGIAR standing panel on impact assessment	• University of Arizona	• Research
F1	A new partnership with international organizations and universities to investigate the role of policy support in curbing GHG emissions and to develop outlooks of the rice economy	• University of Arkansas • Purdue University • UW - University of Washington • FAO - Food and Agriculture Organization of the United Nations • OECD - Organization of Economic Cooperation and Development	• Policy • Research
F1	A new partnership is established with the Islamic Development Bank to implement the Regional Rice Value Chain Program (RRVCP) in 10 African countries	• IDB - Islamic Development Bank	• Delivery
F1	In partnership with Virginia Tech, CIAT conducted the impact assessment of CURE project in Vietnam and Nepal (Paik et al., 2020)	• VT - Virginia Tech	• Research • Other
F1	The African Development Bank mandated AfricaRice to lead the development of the 'Continental	• AfDB - African Development Bank Group	• Delivery • Policy

	Investment Plan for accelerating Rice Self-Sufficiency in Africa' (CIPRiSSA) to support African countries to attain rice self-sufficiency.		
F2	AGRITECHNICA ASIA Live in Myanmar is an effective model for public-private partnerships. This event was organized by IRRI, the Myanmar Rice Federation, the German Agriculture Society, Myanmar Agricultural Mechanization Department	• DLG - Deutsche Landwirtschaftsgesellschaft / German agriculture society • MOAI - Ministry of Agriculture and Irrigation (Myanmar)	• Delivery
F2	Partnership with GrainPro Inc on the introduction of hermitic storage systems in Africa.	• GrainPro - GrainPro Inc	• Delivery
F2	Upgrading rice value chains in Côte d'Ivoire	• CIRAD - Centre de coopération internationale en recherche agronomique pour le développement	• Policy • Delivery • Research
F2	Consumer study in Senegal and the development of new products from rice in Benin	• UAC - University of Abomey Calavi	• Research • Delivery
F2	Multi-disciplinary exploratory missions in Casamance and Groundnut Basin (Senegal)	• ISRA - Institut Senegalais de Recherche Agricole	• Research
F2	Introduce/pilot pop rice and rice cracker technology in Africa; spillover of pop-rice technology to Africa and the design of pilot-scale pop-rice production	• JIRCAS - Japan International Research Center for Agricultural Sciences	• Delivery • Research

	equipment coupled with the rice husk furnace		
F3	Partnership with the Latin American Fund for Irrigated Rice - a public-private partnership of over 30 organizations in 17 Latin-American countries, providing advice on improved crop management and technology adoption	• FLAR - Fondo Latinoamericano para Arroz de Riego	• Delivery • Capacity Development • Research
F3	In Cambodia, CIRAD established partnership with service providers for specific machinery (Larano, a local manufacturer and importer) in sustainable cropping systems, and with companies for production of cover crop seeds	• CIRAD - Centre de coopération internationale en recherche agronomique pour le développement	• Delivery
F3	The Direct Seeded Rice Consortium is a public-private multi-stakeholder research for development platform on direct-seeded rice, with 26 members, out of which 8 are from private sectors, three are international	• BASF - BASF SE • Bayer Crop Science • Corteva AgriScience • JISL - Jain Irrigation Systems Ltd. • Syngenta	• Delivery • Research • Capacity Development
F4	Increasing the capability to develop regional strategies against pest and diseases where we are working in 7 countries through Pathotracer.	• AGI - Agricultural Genetics Institute • IIRR - International Institute of Rural Reconstruction • CARDI - Cambodian Agricultural Research and Development Institute • RUA - Royal University of Agriculture • ICRR - Indonesian Center for Rice Research • PhilRice - Philippine Rice Research Institute	• Delivery • Research • Capacity Development

F4	Collaboration on drone-based phenotyping in Senegal with CIRAAD and CERAAS.	• CIRAD - Centre de coopération internationale en recherche agronomique pour le développement	• Capacity Development • Delivery • Research
F5	Partnership with Corteva enabled genomic selection and increased selection accuracy. Corteva hosted a visit to their MCRC facility in Hyderabad to explain their blast and Brown-plant hopper screening facilities, protocols.	• Corteva AgriScience	• Research
F5	Contribute to development and dissemination of new rice varieties; local capacity development in Madagascar	• CIRAD - Centre de coopération internationale en recherche agronomique pour le développement • AfricaRice - Africa Rice Center • FOFIFA - Centre National de Recherche Appliqué au Développement Rural • AU - University of Antananarivo / Université d'Antananarivo	• Research • Capacity Development • Delivery
F5	Nutrient management and breeding of nutrient efficient varieties.	• FOFIFA - Centre National de Recherche Appliqué au Développement Rural • AU - University of Antananarivo / Université d'Antananarivo • JIRCAS - Japan International Research Center for Agricultural Sciences	• Research • Capacity Development
F5	JIRCAS blast research network with NARES partners to develop breeding lines with blast resistance genes	• JIRCAS - Japan International Research Center for Agricultural Sciences • IRRI - International Rice Research Institute • AfricaRice - Africa Rice Center • PhilRice - Philippine Rice Research Institute • BRRI - Bangladesh Rice Research Insitute • ICFORD - Indonesian Center for Food Crops Research and Development • VAAS - Vietnamese Academy of Agricultural Sciences • RDA - Rural Development Administration (Korea)	• 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
New partnerships were forged between IRRI, IFPRI, CIAT, CIMMYT, and AfricaRice primarily in the context of the CGIAR foresight report which requires collaboration on some modelling issues. It is fundamental for the RICE CRP to show case its own foresight work to be credible and access platforms where global foresight work is undertaken. The best example of that in 2019 was the CGIAR foresight report for which contributions from IRRI, AfricaRice and CIAT were specifically requested. There are important synergies and complementarities between the analyses performed at country levels. These are mostly applications of IFRM and other models focusing on specific reforms. This also includes the work done at the global level which mostly focuses on the medium-to-long-term major challenges facing food systems	PIM, IFPRI, CIAT, AfricaRice, IRRI, CIMMYT	Scientific and efficiency benefits. Collaboration with PIM allows to systematically collect and compile key foresight activities in the CGIAR Centers. The goal is to identify past foresight analysis that was proven useful, ongoing activities of significance, planned and/or desired activities. The collaboration consists in producing joint reports and publications to provide evidence and policy support addressing key issues related to food security, income and employment, natural resources and environment
FP2 facilitated a study on "The state of rice value chain upgrading in West Africa" (forthcoming in Global Food Security in 2020), which is the fruit of a successful collaboration between CIRAD, IRRI and AfricaRice	AfricaRice, IRRI	efficient research
FP2 has maintained collaboration with the cross-cutting CRP A4NH (Agriculture for Nutrition and Health) through the BMGF-funded Drivers of Food Choice (DFC) Competitive Grants Program. Three FP2 scientists participated in the 2019 ANH Academy; two of which were funded by the DFC program and	A4NH	Stronger research

one through FP2		
Several FP2 researchers have contributed to a survey for the "Review on Scaling through Value Chains" launched by Dietmar Stoian (ICRAF) under the CRP PIM (Policies, Institutions and Markets).	PIM	Stronger research
Agronomists from 9 CGIAR centers (AfricaRice, CIAT, CIMMYT, CIP, ICARDA, ICRISAT, ICRAF, IITA, and IRRI) jointly developed concept paper on "Excellence in Agronomy Initiative". Joint project proposal is under development and is submitted to BMGF in 1st quarter in 2020.	ICRISAT, IITA, ICRAF, AfricaRice, CIAT, CIMMYT, IRRI, CIP, ICARDA	Strong collaborative proposal development
To align/harmonize phenotyping protocols, methodologies for genetic analysis and data management systems.	BigData	Scientific benefits by standardizing drone controlled vocabularies
To align/harmonize phenotyping protocols, methodologies for genetic analysis and data management systems.	EiB	Scientific, capacity development and efficiency benefits for standardization and information exchange.
A workshop organized to explore the acceleration of rice breeding improvement included the active participation of invited EiB staff. All centers have engaged in the activities assigned in the year 2019 for modern rice breeding strategies in CoA5.6. Collaboration across Centers on the development of global rice market segments and a unified breeding strategy was very useful and these activities are soon to be completed. IRRI and CIAT are active members of the EiB Platform for breeding program assessment and optimization.	EiB	Accelerated modernization and strengthening of breeding programs

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
S2364 - Monitoring, Evaluation, Learning, Impact Assessment and Gender workshop	On Going	Program/project evaluation/review	This is an annual workshop organized by RICE through FP1 to 1) assess overall progress towards adoption, impact, outcomes, gender, 2) synthesize learnings, 3) adjust theories of change and workplans	
S2370 - Evaluating the reduction in loss due to improved postharvest methods for storage, processing and milling in Assam, India	On Going	Ex-post adoption study	Evaluating the reduction in loss due to improved postharvest methods for storage, processing and milling in Assam, India.	
S2371 - Adoption and impact of Green Super Rice (GSR) varieties in Bangladesh	On Going	Ex-post adoption study	Adoption and impact of Green Super Rice (GSR) varieties in Bangladesh	
S2372 - Adoption and impact of AWD irrigation technology in Bangladesh	On Going	Ex-post adoption study	Adoption and impact of AWD irrigation technology in Bangladesh	
S2515 - Monitoring and Follow-up survey of the rice sector in Latinamerica (in spanish: Encuesta de Monitoreo y Seguimiento del Arroz Latinoamericano-EMSAL)	On Going	Qualitative Outcome Study: (mainly to substantiate contribution to policy or similar)	Regional expert panel consultation	
S2853 - Household survey data of adoption of improved varieties and management practices in rice	On Going	Other MELIA activity	This article provides a description of an agricultural household survey data of rice growers collected in Ecuador between October 2014 and March 2015. The household survey was implemented using a structured questionnaire	

production, Ecuador			administered among 1,028 households in the main rice production areas of Ecuador. Information collected was provided by household heads and included household and plot level data. The survey information includes household socio-demographic characteristics, farm characteristics (e.g. farm land size, assets ownership, other crops planted, etc.), rice management practices (e.g. variety and input use, production costs, etc.), and rice production and utilization (e.g. yields, prices, sales, etc.)	
S2855 - Ex-ante impact evaluation of the L23 rice genotype on the colombian Altillanura plains	On Going	Program/project evaluation/review	The objective of this work was to implement an ex-ante economic evaluation to estimate the results and potential impacts of the new promising L23 rice line improved for the Colombian Altillanura. The ex-ante evaluation combined a partial budgets analysis with information from experimental tests and economic surpluses model. The two methodological approaches were consistent and showed that with the adoption of the L23 genotype at least 29.7%, a probability of 17.1 % could be achieved for rice producers in the Altillanura due to the expected increase in crop yield.	
S2857 - The seven samurai of Latin American rice improvement	On Going	Ex-post adoption study	They're not the biggest rice producers in Latin America and the Caribbean (LAC). But, like the seven samurai of the famous 1954 adventure film, they're certainly among the boldest, and they fight hard to improve the lot of rice-growing communities. These seven countries are Bolivia, Costa Rica, Ecuador, Nicaragua, Panama, Peru, and Venezuela. Their national programs are currently engaged with the impact evaluation team at the Colombia-based International Center for Tropical Agriculture (CIAT) in a study on the adoption of improved rice varieties, CIAT's role in their development, and their impacts on rice productivity.	
S2862 - VARIEDADES MEJORADAS MODERNAS DE ARROZ UN ESTUDIO DESDE EL MARCO DE ADOPCIÓN DE TECNOLOGÍAS PARA BOLIVIA	On Going	Ex-post adoption study	El sector arrocero en Latinoamérica ha experimentado cambios significativos durante los últimos 40 años, mostrando incrementos en los rendimientos que llegan a ser del triple, en promedio. Sin embargo, este no ha sido el caso de Bolivia. Tomando en cuenta la posible brecha tecnológica afrontada por el sector arrocero boliviano, este documento analiza los determinantes en la	

			adopción de variedades mejoradas modernas de arroz (MIVs, por sus siglas en inglés) a través de los productores pequeños y medianos de este país.	
S2863 - Adoption and impacts of international rice research technologies	On Going	Synthesis (secondary) study	116 million tons by 2035. Much of the increase has to come from smallholder rice farmers in developing countries. In this article, we review 25 evaluation studies on new rice technologies and practices that have been tried and used by smallholder rice farmers in developing countries. Stress-tolerantrice varieties are found among promising new rice varieties. African farmers benefit from New Rice for Africa (NERICA) varieties. Some natural resource management (NRM) practices have been evaluated in farmer trials and found beneficial. However, the NRM evaluation studies faced with difficulties in defining NRM “technology” and “adoption”	
S2864 - Participación de mujeres y hombres en la producción de arroz en Ecuador	On Going	Other MELIA activity	La información desagregada según género es uno de los aspectos fundamentales para develar las contribuciones que hacen diferenciadamente hombres y mujeres a la agricultura e identificar las posibles desigualdades de género presentes en los sectores rurales. Este hecho cobra aún más importancia en contextos en donde usualmente las mujeres no se reconocen como agricultoras o agentes importantes para el desarrollo agrícola; siendo el caso del sector arrocero en países de América Latina (Muriel, 2013; Twyman, Muriel y García, 2015; García, 2015).	
S2865 - The Impacts of CIAT’s Collaborative Research	On Going	Other MELIA activity	The International Center for Tropical Agriculture (CIAT) is celebrating 50 years of collaborative work with hundreds of partners across the tropics. During 50 years, CIAT has led the development and dissemination of technologies, innovative methods, and new knowledge that better enable farmers to enhance eco-efficiency in agriculture and contribute to building a sustainable food future. CIAT scientists have compiled an impressive record of achievements. In the interests of accountability to donors and other stakeholders, and to help lead the Center’s strategic research investments, they have also devoted considerable effort to measure the economic impact of their work.	

S3265 - Impact of ECOWAS Common External Tariffs on Food Security and Nutrition in West Africa	Completed	Ex-ante, baseline and/or foresight study	The Regional decision-makers have evidence of the impact of the CET on rice production, consumption, bilateral trade, and consumer, producer, and government welfare at the regional and global level, and the potential policy implications of such change. Nigeria stands to see the deepest changes in its rice market from the implementation of ECOWAS's CET, which will benefit consumers at the expense of producers and the government and results in net welfare gains. Ghana, Guinea, and Mali also stand to have net welfare gains because of the implementation of the CET.	
S3266 - Promotion of youth employment in the rice value chain in Africa	On Going	Program/project evaluation/review	Inclusive collaboration with the national initiatives on youth employment, international organization (CTA/EU, 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 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.	
S3267 - Regional and National Rice Development Strategies for Food Security in West Africa	Completed	EPIA: Ex-post Impact assessment	Expansion of rice production in West Africa displaces nearly 25% of global rice trade, thus undermining production in more efficient rice-producing export countries such as India, Thailand, and Vietnam. Benefits to West African consumers include lower rice prices. A coordinated policy sequencing approach toward enhancing productivity and quality of rice production- as well as increasing investment in infrastructure, institutions, and emergency food reserves- should be studied more thoroughly to achieve food and nutritional security for West Africa.	

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

Name of the evaluation	Recommendation number (from evaluation)	Text of recommendation (can be shortened)	Status of response to this recommendation	Concrete actions taken for this recommendation.	By whom (per action)	When (per action)	Link to evidence
No new evaluations in 2019	-	-	Complete	-	-	-	-

Table 12: Examples of W1/2 Use in this reporting period (2019)

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.
The impact assessment study on stress-tolerant varieties was made possible through SPIA grant with co-funding from RICE W1W2. The W1W2 pre-investment in drafting the proposal has been instrumental in securing the SPIA grant	Other Monitoring, learning, evaluation and impact assessment (MELIA)
IRRI, AfricaRice and CIAT used W1W2 funds to document evidence on adoption and dissemination of rice technologies in Asia, Africa and Latin America, as requested by SPIA. The final output of this activity supported the development of a joint proposal on assessing the large scale impact of rice agronomic practices.	Other Monitoring, learning, evaluation and impact assessment (MELIA)
W1W2 was used to assess the impact of Smart-valley in Liberia and Sierra-Leone, to assess the impact of ARICA 6 in Guinea, and to assess adoption and impact of GEM parboiling in Nigeria and Cote d'Ivoire.	Other Monitoring, learning, evaluation and impact assessment (MELIA)
With W1W2 funds, panel data were also collected in 7 countries: Nigeria, Benin, Cote d'Ivoire, Sierra Leone, Liberia, Senegal and Mali.	Other Monitoring, learning, evaluation and impact assessment (MELIA)
Development of the cross-center manuscript "The state of rice value chain upgrading in West Africa" forthcoming in Global Food Security in 2020) by CIRAD, IRRI and AfricaRice.W1-2 funding enabled collecting primary evidence in Senegal, Burkina Faso, Mali, and Côte d'Ivoire.	Research
Verification of the new GrainSafe Dryer with national partners in countries where we did not have bilateral projects. Piloting the strengthening of value chain support services (machinery design, repair and maintenance) at university and vocational levels. This was a W1/2 funded proof of concept.	Partnerships
Adaptive research on fan-assisted rice husk fueled stoves for parboiling	Research
Developing a prototype and adaptive research on a fan-assisted rice husk fueled flat-bed dryer	Research
Studies on gluten free, fully gelatinized carbohydrate source for infant formulas	Research

Studies on the production of healthy (low glycemic and micronutrient enrich) rice.	Research
Support internship for two interns (1 MSc student and 1 Cooperative Manager) to study at AfricaRice Grain quality and Post-harvest Unit	Capacity development
GEM parboiling equipment support to two cooperatives (Bouaké Innovation Platform and Société Multiservices Agricoles Sarl, Senegal).	Partnerships
Catalyzing research spillovers between JIRCAS and AfricaRice through a visiting FP2 scientist conducting research on Kuai chap properties and pop-rice technology. The majority of the funding has been used for acquisition of High Performance Liquid Chromatography (HLPC) for isolation and preparation of rice components.	Partnerships
In IRRI, W1/2 funds complemented many activities under bilateral funding e.g. the Direct Seeded Rice Consortium; best management practices in the ACIAR rice-fish project; and the World Bank Agricultural Development Support Project (ADSP) in Myanmar - activities were funded that were not covered by the bilateral grants.	Pre-start up
In AfricaRice, W1/2 funds were used for support key staff in FP3, workshop on introduction of MALRO, planned research activities mainly in Madagascar including gender analyses, mechanization studies, and farm diversification surveys and trials.	Research
CIRAD used W1/2 funds for support field technicians and students for activities focused on diagnosis, prototyping and assessment of diversified upland rice cropping systems, including on-farm and controlled experiments studies in Madagascar. Also, they were used for Supports were also used for publication of scientific communications and papers	Capacity development
In Cambodia, W1/2 funds were used to support field technicians who conduct activities with farmers, field tours, but also for the field preparation, land levelling and material acquisition for the pluriannual trial in the research station.	Partnerships
In JIRCAS,W1/2 funds were used for support a post-doctoral fellow, and trip costs of research members from Japan to Madagascar, and costs of consumables and local technicians incurred by the implementation of field trials in Madagascar.	Capacity development
In FP4, we successfully established field trials and common data collection protocols were shared. Drone-based phenotyping is being done at 4 sites. [RCMC(B1] Pathotracer tool was piloted in 7 countries and it is ready to be scaled up in the region.	Partnerships

Table 13: CRP Financial Report (all in US$)

	Planned Budget 2019*			Actual expenditure*			Difference*			Comments
	W1/W2	W3/Bilateral	Total	W1/W2	W3/Bilateral	Total	W1/W2	W3/Bilateral	Total	
F1 - Accelerating impact and equity	2,957,523.42	11,167,466.55	14,124,989.97	3,057,706.52	10,877,964.29	13,935,670.81	100,183.10	289,502.26	189,319.16	-
F2 - Upgrading rice value chains	1,350,446.49	5,340,244.99	6,690,691.48	1,159,928.86	1,318,152.27	2,478,081.13	190,517.63	4,022,092.72	4,212,610.35	-
F3 - Sustainable farming systems	2,194,694.95	12,334,211.60	14,528,906.55	1,969,486.09	11,698,660.32	13,668,146.41	225,208.86	635,551.28	860,760.14	-
F4 - Global	2,383,390.35	2,400,995.57	4,784,385.92	2,208,983.18	2,865,730.71	5,074,713.89	174,407.17	-464,735.14	-290,327.97	-

Rice Array										
F5 - New rice varieties	3,333,912.48	34,224,019.22	37,557,931.70	3,433,684.31	24,255,916.53	27,689,600.84	-99,771.83	9,968,102.69	9,868,330.86	-
Strategic Competitive Research grant	.00	.00	.00	.00	.00	.00	.00	.00	.00	-
CRP Management & Support Cost	1,271,622.00	.00	1,271,622.00	1,276,317.98	.00	1,276,317.98	-4,695.98	.00	-4,695.98	-
CRP Total	**13,491,589.69**	**65,466,937.93**	**78,958,527.62**	**13,106,106.94**	**51,016,424.12**	**64,122,531.06**	**385,482.75**	**4,450,513.81**	**14,835,996.56**	

Annexes

Table Annexes

FP	Detailed Annex
F1: Accelerating impact and equity	- In India, women-headed households, Scheduled Tribe and Scheduled caste exhibit higher adoption rates for STRVs. Engagement of women as seed producers catalyses adoption. Women users prefer seed from women producers due to easier access and trust in quality.- Bacud et al (2019), found that in Vietnam, migration contributes to increased off-farm income, with higher income from international migration. While men's labour contribution declines in migrant households, women's labour increases in the majority of production stages.- In Vietnam, Bacud et al (2019), found that there is a negative association between increased women's work burden and rice yield. Farm inputs and hiring labour contribute to higher yield, but remittances are not generally used for this purpose.- Zossou et al. (2019) analyzed factors influencing farmers in acquiring agricultural knowledge and adopting technologies in 5 African countries. Gender gap was observed in Côte d'Ivoire and Niger on knowledge about agricultural technologies and use of improved farming methods.- The adoption of "smart-valley approach" increased yield by 0.9 t/ha and income by 267 US$/ha in Benin (Arouna and Akpa, 2019). The impact is greater for men than for women (0.95 tons/ha for men and 0.88 tons/ha for women).- The adoption of Smart-Valley technology in Togo showed that despite the participation of female farmers in trainings on the technology, the implementation by women was limited by the required physical effort and labour (Arouna and Akpa, 2019).- Arouna and Akpa (2019) noticed that women's role in Smart-Valley adoption remains relegated to less labour-demanding, less rewarding activities (e.g. fetching water, preparing meals). Adoption will be improved if emphasis is on group learning and collective action.- Promoting salt-tolerant rice varieties in lowland ecologies allows recouping rice production in salt-affected areas, retaining rice-farming communities' source of livelihood and maintaining the essence of the role of women as a food providers in households (Senegal).- Women groups serve as channels for empowering women by providing labour and participating in income generating activities. Women associations serve as channels to access knowledge and skills for seed production, and to have access to land for farming (Madagascar).- Understanding trait preferences to contribute to gender responsive breeding priorities, studies reveal that yield remains a key needed attribute for male and female farmers. Value added traits such as grain quality and stickiness are also important to farmers (Madagascar).- Women's entry into profitable businesses is limited mainly by the lack of awareness, skills, capital, basic business tools and the perception on gender-specific nature of some farming activities (Nigeria).- The SWOT analysis

	on promoting women and youth entrepreneurship in Madagascar revealed that while access to finance remains a key challenge, allocating land to female groups and the promotion of co-financing and self-help contributions help alleviate the financial constraint.- A Youth strategy has been developed and is under review for publication. The strategy is built on a resilience framework and is designed with a goal of engaging youth to contribute to and benefit from sustainable rice agri-food systems.- A workshop was conducted to share the review in the Youth strategy. The review threw out very interesting issues and trying to frame both the review and strategy in the context of climate change worked well.- The workshop involving young people to capture their voices, perceptions, aspirations, choices and needs was very effective and gave a new flavor to the thinking. This also highlighted potential partners to work in this area to implement the strategy.- To promote youth employment in the rice value chain within the PEJERIZ project (funded by CTA-EU/ACP), 103 youth business plans were developed (52 business plans for Senegal and 51 for Mali representing 38% female and 62% male).- Training on the use of ICT and social media for agribusiness were organized for 204 youth agripreneurs (104 in Mali and 100 in Senegal, representing 32% female and 68% male) to enhance their entrepreneurial skills.- Before the ICT training, 3 to 13 % had experience in the use of ICT and social media in agribusiness. After the training, more than 70 % of youth are willing to use the tools for networking and communication.- Training was organized on rice seed production technologies for 32 youth in Nigeria and Benin Republic) to enhance their skills and provide them employment opportunities in the agricultural sector.- 120 youth seed entrepreneurs trained by AfricaRice in Ibadan between 2016 and 2018 have engaged other youths in the seed production businesses in Nigeria. Tangible achievements include selling seeds to off-takers (Reza Agro Services in Akwa Ibom State).- Analysis of rice production systems in Senegal and Mali showed no significant difference in yield and profitability between youths and adults. The rainy season in Mali and the dry season in Senegal have higher yield and are more profitable.
F2: Upgrading rice value chains	- FP2 has further expanded its research and training portfolio on market analysis for gender-responsive product profiling in 2019.- Consumer demand for rice fragrance in South and Southeast Asia is found to be mainly driven by women. These insights can assist rice breeding programs in developing gender-responsive product profiles (Bairagi et al., in press, British Food Journal).- Demand for heritage rice produced by indigenous communities is found to be mainly driven by women. This can inform cultural heritage preservation strategies based on the commoditization of heirloom rice (Bairagi et al., under review, Agriculture and Human Values).- A novel indicator for women empowerment was developed. Women were found to be more empowered if they were engaged in off-farm employment, which argues for increasing gender inclusiveness of rice value chain upgrading (Maligalig et al., 2019, Journal of Rural Studies).- Indicators elicited through gamification experiments are found to be an efficient way for measuring empowerment. FP2 will facilitate spillover of this method to food choice research (e.g., Demont et al., 2019, Geography You).- A qualitative study conducted in five communes in Benin found that the GEM parboiler lifts more women out of poverty than men.- In

	Casamance (Senegal), rainfed rice cultivation is found to be predominantly a female activity. Women have limited access to motorization and inputs, though. Food security can be enhanced by increasing women's labor productivity through improved access to production factors.- FP2 has conducted a study on preserving cultural heritage of indigenous rice communities in the northern Philippines through commoditization of heirloom rice. Results indicate a potential market size of PHP 15.7 billion (USD 344 million) that could be created for heirloom rice and tapped into by heritage farmers (Bairagi et al., under review, Agriculture and Human Values).- FP2 published a policy article on inclusiveness of contract farming in Vietnam. The findings highlight the role policies encouraging horizontal and vertical coordination can play in fostering inclusiveness in rice value chain upgrading (Ba et al., 2019, Land Use Policy).- The curriculum development for Agricultural Engineering (BSC) and Agricultural Machinery Mechanics done in In CoA 2.2 in Cambodia resulted in around 20 graduates of each course leaving entering the agricultural job markets in Cambodia each year.- In 2019, FP2 engaged 65,000 smallholder farmers, parboilers and marketers in GEM parboiling related activities in five African countries (Benin, Cote d'Ivoire, Niger, Nigeria, Togo). More women and youth are now involved in rice processing following the installment of GEM parboiled rice processing facilities in several sites across Africa. The GEM rice processing facilities provide poor farmers who are vulnerable to paddy collectors the option to add value to their rice before selling.- A study on the rice value chain in Côte d'Ivoire has identified drivers of farmer inclusion in contract farming and the drivers of improved seed adoption.- FP2's research on sustainable rice value chain upgrading generated a major policy publication on inclusiveness of contract farming (Ba et al., 2019, Land Use Policy), which can be used as an entry point for internalizing sustainable production standards and mitigating climate change in rice value chains.- FP2 developed a draft policy brief with strategies for becoming a global leader by institutionalizing sustainable rice production guidelines in Vietnam, which can be considered as a first step in mitigating climate change in the rice sector with important spillover potential to other countries.- Almost all postharvest practices developed under FP2 are related to climate change, optimizing operations leads to reduced energy consumption and this less emissions and reducing postharvest losses also reduces emissions created by manufacturing and applying the inputs used for growing and processing the lost grains. We have conducted Live Cycle Assessments comparing various operations and technologies (e.g. drying systems, different rice straw management options, etc.) which resulted in science based evidence about environmental sustainability of those options. The output of this work has been used in formulating the postharvest indicators for the Sustainable Rice Platform (SRP) and policy workshops have been conducted in Vietnam, Cambodia and the Philippines using this data.- FP2 research in Africa has demonstrated that substituting wood for rice husk as fuel for parboiling (Mini-GEM parboiling) saves costs linked to wood purchase, reduces deforestation and greenhouse gas emissions. Utilization of rice husk furnaces is further found to reduce CO2 emissions.

F3: Sustainable farming systems	IRRI: Laser land leveling established in Cambodia and Vietnam (Innovation #612): in Vietnam and Cambodia, the technology has been extensively demonstrated and services are provided by government institutions, but private sector contract service provision is not yet established. Laser land leveling in Indonesia, Philippines, Myanmar, Sri Lanka (Innovation #613): in Thailand we provided support to CropTech Asia, national distributor of laser leveling equipment and inputs to the NAMA project of the Rice Department, that aims as scaling out business models and loans for laser leveling and other climate smart technologies. We conducted a multi stakeholder Laser Leveling round table discussion with the different stakeholders on December 2 in Bangkok during the AGRIFUTURE conference to discuss roles for the dissemination. For Myanmar we facilitated with TRIMBLE Australia, CropTech Asia Thailand and Pioneer Agribiz Myanmar the establishment of the supply chain for laser leveling equipment. Four sets of equipment were purchased in 2019 for large scale demonstrations through national projects. AfricaRice: Through technologies for African Agricultural Transformation (TAAT), rice component in "Putting Research into Use for Nutrition, Sustainable Agriculture and Resilience (PRUNSAR)" program", and RICE CRP FP3, we disseminated innovations such as RiceAdvice and good agricultural practices to 35,000 farmers in Burkina Faso, Madagascar, Mali, Nigeria, Senegal, and Uganda. Working report on Randomized control trial in northern Nigeria showed that use of RiceAdvice had 15 % higher yields and 20 % higher profits. 1,000 farmers' rice cultivation practices were assessed using Sustainable Rice Platform Standard and Performance Indicators in Burkina Faso, Ghana, Nigeria, Senegal, and Tanzania. Diversification options were jointly tested with farmers in Cote d'Ivoire, Madagascar, and Senegal. CIRAD: In Madagascar, together with scaling partner - GSDM (Groupement du Semis-Direct à Madagascar), CIRAD organized field days which around 300 farmers were invited to. During these days, a concept of multiple-purpose services in diversifying upland rice-based cropping systems, i.e. protein supply for human and livestock as well as market (pulses), pest control, nutrient supply to soils, and rice productivity enhancement were introduced to those farmers. The next step is that based on data from field experiments and feedback from those farmers, technology dissemination tool (brochure, leaflet) will be developed in the Malagasy language, and will be disseminated. In Cambodia, testing of diversification options in lowland rice-based systems by introduction of legume crops as rotational crop were initiated and involved farmers and service providers for cropping system designing. JIRCAS: A partner JIRCAS project identified that P-deficiency as ascribed from both low total phosphorus contents and dominance of insoluble P forms in soils is a major constraint for rice production in the central highlands of Madagascar and that the amounts of oxalate-extractable phosphorus in soils can be an appropriate index to evaluate P deficiency status of rice fields. In addition, JIRCAS developed a rapid estimation technique of oxalate-extractable P in soils using visible and near-infrared diffused reflectance spectroscopy with partial least squares regression. Under such an edaphic constraint, JIRCAS indicated that the introduction of *Stylosanthes guianensis* in the farming system could be one potential measure to improve nutrient use efficiency and crop production. *Stylosanthes guianensis* was shown to have superior solubilizing capacity of Fe-bound P in soils in pot experiment and

	superior P uptakes by 10- to 26- fold relative to the other major crops (rice, maize, and soybean) in field experiment. Another field experiment has been conducted to assess the positive impact of *Stylosanthes guianensis* on the succeeding upland rice yield and P uptakes. According to the field survey for 2 sites in the central highlands of Madagascar, a sowing window of rainfed rice farmers was for 1-2 months and grain yields showed a negative correlation with sowing timings which indicated sowing timing as a crucial factor to improve productivity and fertilizer use efficiency of upland rice. FLAR (The Latin American Fund for Irrigated Rice (FLAR, by its acronym in Spanish): In Brazil, we completed the third year of work on the Project 10 plus, in partnership with the Rio Grande Do Sul State Rice Institute (IRGA, by its acronym in Portuguese). In the 2018-2019 harvest season, 2,684 producers and technicians (15.5% women) participated in field activities across the state. In total, 118 demonstration plots were cropped, covering an area of 3,790 hectares. The proposed improved management obtained an average of 9,400 kg ha-1, 12% higher than the conventional management in side-by-side commercial lots. In a three-year average, rice yields were 19% higher than the conventional management with a reduction of 25% in production cost. The results of the project and the wide adoption of the technologies throughout the state, in approximately 1.1 million hectares of rice, demonstrate how improved agronomy and technology transfer in alliance with national organizations were able to effectively increase yields and reduce production costs, contributing in this way to the sustainability of rice in southern Brazil.
F4: Global Rice Array	CIRAD conducted experiments with RP in Madagascar at two different sites above sea level (asl). First, Ivory at 950 m asl and second Antsirabe at 1650 m asl. For CIAT the details of the Phenotyping platform are available at the online presentation: https://www.youtube.com/watch?v=hnq_ydC1-rwfeature=emb_logoanalyze. In the case of IRRI, the introgression lines were advanced for BPH resistance derived from *O. longistaminata, O. rufipogon, O. punctata, O. rhizomatis, O. australiensisand O. granulate*. InDel markers were identified for discriminating O. sativa and other wild species of the AA-genome composition. For Phytobiomes, the 3000 rice genome metadata was used to identify genomic regions that affect community assembly. For AfricaRice the project wise description is as follows: CoA 4.1: Worldwide field laboratoryAP evaluated under irrigated conditions in Senegal (Sahel Climate Zone) and Cote d'Ivoire (Humid Forest Climate Zone). Six trials completed at these two sites revealed high-yielding, short-duration genotypes of interest. Location-specific performance was noted, probably due to temperature variation between the trial sites. In Senegal, cold stress can occur at the reproductive stage during wet season (in case of late planting) and at plant emergence during the dry season (in case of early planting). Varieties showing high yield were not consistent among the three trials in Senegal—IRGC 79837-1 had highest yield in the dry season and BR28, Supa and IRRI 104 did in the wet season. In Cote d'Ivoire, NSIC Rc240, Giza 178, IRGC 79837-1 and UPL RI 7 consistently showed high yields in the three trials. CoA 4.2: Global phenotypingRP evaluated under irrigated conditions in Senegal and Cote d'Ivoire. Significant GxE variation was noted. In Coted d'Ivoire several lines

	outperformed the local check WITA9 while in Senegal, the local check Sahel 108 was among the best. Potential sources of tolerance to salinity were also observed. Plant phenotyping capacities were upgraded in Cote d'Ivoire and Senegal by rehabilitating field sites for the evaluation of Fe-toxicity and salinity. A drone-based phenotyping platform (fixed wing eBee-Plus drone with S.O.D.A RGB and SEQUOIA Multispectral cameras) was established and used to monitor trials in Bouake (Cote d'Ivoire). Additional quadcopter drones, e.g. DJI Matrice 200 V2 with XenMuse X5s sensor and DJI Phantom 4 Pro with built-in 5 bands Multispectral sensor, and tow Emlid Reach RS+ GPS survey kits are being acquired for Bouake (Cote d'Ivoire) and Saint Louis (Senegal), respectively, as well as hardware equipment for image-data storage, processing and analysis at AfricaRice.CoA 4.3: Genetics of rice plant interactions with the biotic environment. In collaboration with IRD and NARES at LMI Patho-Bios in Burkina-Faso, a new diagnostic multiplex PCR assay was refined using AfricaRice's strains collection. This assay was designed by the LMI Patho-Bios to potentially discriminate multiple pathogens including *Xanthomonas oryzae pv. oryzae* and *pv. oryzicola, Pantoea sp., Sphingomonas sp., Burkholderiasp. and Pseudomonas fuscovaginae*. Selected accessions in the antenna panels grown in M'be, Bouake, Cote d'Ivoire, were scored for resistance to major diseases (bacterial blights, Rice Yellow Mottle Virus (RYMV) and blast). Potential sources of resistance will be confirmed before being recommended to breeders. Several trials were conducted in M'be to monitor diseases incidence and changes in the pathogen population over the years and to identify accessions/genes that hold durable resistance. Available data being analyzed:- Blast: Three-year data generated using a set of 81 differential lines in the background of LTH or CO39 as well as in improved lines and traditional accessions/varieties.- Rice Yellow mottle virus (RYMV): Multi-season data of six varieties harboring known resistance genes/alleles - IR64 (rymv 1-1), Gigante (Rymv1-2), Tog 5681 (rymv 1-3), Tog5307 (rymv 3), Tog 5674 (rymv1.5), Tog 5672 (rymv 1-4, rymv 2 rymv 3) as well as Bouake 189 and BG90-1.- Rice Stripe Necrosis Virus: Based on previous research activities, a set of 6 varieties known to be susceptible or resistant to the disease were considered: susceptible (Oryzica 3 and Faro 44 (SIPI 1692033)), resistant (MG 12 and NERICA 18) and moderately susceptible (Sahel 108 and Sahel 134).- Pantoea blights: Accessions known to be susceptible or resistant were tested at M'be and include Adny 11, Azucena, C101 A 51, Gigante, IR24, Moroberekan, NIL 130, PNA 647 F4-56 and Sahel 201.- Bacterial leaf blight (*Xanthomonas oryzae pv. oryzae*): A set of 22 entries including 20 IRBB differential lines harboring known resistance genes (IRBB1-8, IRBB10-11, IRBB13-14, IRBB21, IRBB50-55, IRBB59-60), Gigante and IR24.
F5: New rice varieties	In CoA 5.1 (Harnessing genetic diversity), screening and validation experiments using germplasm panels and populations resulted in the discovery of novel donors and genomic regions associated with anaerobic germination, stagnant flooding, grain Zn content, sheath blight tolerance, and drought/direct seeded rice; 50 potential donors have been selected for gap analysis with DST elite lines and a BIL (*rufipogon x indica*) was selected for use in the stress breeding program. JIRCAS screened 250 accessions from the 3K

	panel for grain Zn concentrations and identified 2 potential new donors combining above-average yield with grain Zn concentrations above 35 ppm. It developed a genomic prediction (GP) model to estimate grain Zn concentrations among the 3K accessions to facilitate the identification of additional donors. CoA 5.2 (Precision breeding) reports loci controlling extreme early flowering and maturity of a Madagascan landrace identified, and introgression advanced to BC4 generation. Deployment of some 12 genes into IRRI 154 was completed; for most this is the first time they have been available in an elite background. Over 100 trait markers targeting 55 high-value loci designed and implemented at 3 different service providers. The RiCA panel implemented at DArT in Australia to provide an alternative to Agriplex. Introgression of RYMV resistance genes advanced, with progeny starting to show some restoration of fertility. Analysis tools to convert trait marker information to easily-interpreted trait calls developed and distributed to partners. The core 25 lines from the Irrigated core panel were sequenced, and plans are in place to sequence the remainder. For FP5.4 (Unfavorable ecosystems), phenotypic evaluation of the rainfed-core breeding panel (RCP 1.0) across Asia and Africa was conducted in the year 2019. A set of 296 lines was screened in 11 sites in South Asia and 8 sites in East and Southern Africa. One QTL for stagnant flooding tolerance was identified using a bi-parental population. The results of this study are now being compiled as a manuscript. International Network for Genetic Evaluation of Rice (INGER) a rice germplasm testing network sent rice germplasm trials in 18 countries (79 locations for biotic stress and 88 locations for abiotic stress). Multiple breeding lines were nominated in release pipelines or released as new varieties for countries in South and South East Asia. Some of these include IR10F365 and IR13F265 for flood prone areas in Philippines; IR13F115 and IR12F578 for flood prone areas in Nepal, Bahuguni dhan 1 and 2 for flood and drought prone areas in Nepal and Inpari 46 for rainfed lowland drought and coastal saline regions in Indonesia. IR13F265 is identified for release in the Philippines. Pre-breeding for lowered glycemic index with acceptable texture was conducted. Reliably generating rice varieties with low glycemic index (GI) is an important nutritional intervention given the high rates of Type II diabetes incidences in Asia where rice is staple diet. We integrated a genome-wide association study (GWAS) with a transcriptome-wide association study (TWAS) to determine the genetic basis of the GI in rice. GWAS utilized 305 re-sequenced diverse *indica* panel comprising ~2.4 million single nucleotide polymorphisms (SNPs) enriched in genic regions. A novel association signal was detected at a synonymous SNP in exon 2 of LOC_Os05g03600 for intermediate-to-high GI phenotypic variation. Another major hotspot region was predicted for contributing intermediate-to-high GI variation, involves 26 genes on chromosome 6 (GI6.1). These set of genes included GBSSI, two hydrolase genes, genes involved in signaling and chromatin modification. The TWAS and methylome sequencing data revealed cis-acting functionally relevant genetic variants with differential methylation patterns in the hot spot GI6.1 region, narrowing the target to 13 genes. Conversely, the promoter region of GBSSI and its alternative splicing allele (G allele of Wxa) explained the intermediate-to-high GI variation. A SNP (C>T) at exon-10 was also highlighted in the preceding analyses to influence final viscosity (FV), which is independent of amylose content/GI. The low GI line with GC haplotype confirmed

	soft texture, while other two low GI lines with GT haplotype were characterized as hard and cohesive. The low GI lines were further confirmed through clinical in vivo studies. Gene regulatory network analysis highlighted the role of the non-starch polysaccharide pathway in lowering GI.To accomplish the 1.3% of genetic gain in intensive systems, CIAT-FLAR tested 30 breeding lines in multi-environmental trials in six countries of LAC in the FLAR network. Four varieties of CIAT-FLAR germplasm were released in three countries of LAC. In unfavorable ecosystems, CIAT identified two QTLs for drought stress. For high-quality and nutritious rice, CIAT-CIRAD –Harvest plus release a high zinc varieties in Bolivia and Colombia increasing around 8 ppm the zinc content. In terms of quality improvement we develop and validate in 2019, three molecular marker for amylose content, gelatinization temperature and chalkiness, key components of rice quality. JIRCAS developed near isogenic lines(NILs) for true blast resistance genes, Pii, Pi3, Pik, Pik-h, Pikp, Pi1, Pi7(t), Piz, Piz-5, Pi9(t), Pi12(t), Pish and improved resistance was confirmed by an inoculation test with international standard differential blast isolates. To develop NILs for partial resistance genes (pi21 and PB1) hybrid populations (BC5F2 and BC6F2) were generated for the selection of homozygous plants

RICE's Mission

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

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

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

These outcomes will be possible by

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

Flagship projects

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

CGIAR RESEARCH PROGRAM ON Rice

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

AfricaRice

IRRI

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

cirad
AGRICULTURAL RESEARCH FOR DEVELOPMENT

IRD
Institut de Recherche pour le Développement
FRANCE

JIRCAS