CRP 2020 Reviews

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Publication date:
2020

Citation for published version (APA):
Yadav, R., & Kumar, R. (2020). *CRP 2020 Reviews: Rice Agri-Food Systems (RICE)*. CGIAR Advisory Services.

Advisory Services

CGIAR

CGIAR Research Program 2020 Reviews: Rice Agri-Food Systems (RICE)

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December 2020

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Correct citation: CAS Secretariat (CGIAR Advisory Services Shared Secretariat). (2020). CGIAR Research Program 2020 Reviews: Rice Agri-Food Systems (RICE). Rome: CAS Secretariat Evaluation Function. https://cas.cgiar.org/

Cover image: Laguna harvest. Credit: IRRI

Design and layout: Luca Pierotti and Macaroni Bros

CGIAR Research Program 2020 Reviews: Rice Agri-Food Systems (RICE)

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Acknowledgments

This evaluation was prepared by a team led by Ravinder Kumar, providing senior evaluation expertise, and the subject matter expertise provided by Rattan Yadav.
The two-person team worked under the overall direction of Allison Grove Smith, Director, CGIAR Advisory Services Secretariat. These reviews are being led by the CAS Secretariat Senior Evaluation Manager Svetlana Negroustoueva. Ravi Ram, Senior Evaluation Consultant to CAS Secretariat, managed the first cohort of three CRP2020 Reviews – A4NH, GLDC and WHEAT. Angela Giménez Barrera provided technical evaluation expertise for the review process. Paolo Sarfatti served as senior advisor to the evaluative reviews project 2020. Gaia Gullotta and Max Runzel provided analytical support. Rodomiro Ortiz served as a peer reviewer of the preliminary findings and final report.
CAS/Evaluation and the review team gratefully acknowledge RICE CRP Team and the CGIAR System Organization for their support: Julien Colomer and Hector Tobon.

CAS Disclaimer

By design, the CGIAR Results Dashboard was a key source of data for the 2020 CRP Reviews. During the pilot phase of the CRP Reviews, issues with interoperability and resulting data quality between the management information systems (CLARISA and the Dashboard) and extracts from CRP systems (MARLO and MEL) were discovered. For harmonization, CAS engaged with the MARLO team and the CRP MEL focal points to conduct data cleaning and pre-analysis for CRP review teams. This exercise revealed the limitations of CGIAR's reporting/repository systems for evaluation purposes; these limitations were mostly due to changing reporting requirements and discrepancies in whether CRPs adopted MARLO or MEL systems. Moreover, in the case of peer-reviewed journal articles, the protocol used by the CRP review teams to identify relevant publications differed from the guidance applied by CRPs (the CRP review teams' bibliometric analysis used only publications indexed by International Scientific Indexing [ISI], available through Web of Science). Therefore, CAS acknowledges discrepancies between the CGIAR Results Dashboard, and the data provided to the Review teams for their analysis, which should not be seen as a factor having influenced the analysis by the CRP review teams.

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A4NH	Agriculture for Health and Nutrition CRP
AfricaRice	AfricaRice Centre
ARI	advanced research institute
ASEAN	Association of South East Asian Nations
AWD	alternate wetting and drying
BMGF	Bill & Melinda Gates Foundation
CARD	Coalition for African Rice Development
CAS	CGIAR Advisory Services Secretariat
CCAFS	Climate Change, Agriculture and Food Security CRP
CIAT	Centro Internacional de Agricultura Tropical
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
CoA	cluster of activities (under a flagship project within the CRP)
CoPCM	Community of Practice on Crop Modeling
CORIGAP	Closing Rice Yield Gaps
CSISA	Cereal Systems Initiative for South Asia
CRP	CGIAR Research Program
CURE	Consortium for Unfavorable Rice Environment
DSR	direct-seeded rice
EC	European Commission
ESA	Eastern and South Africa
FLAR	Fondo Latinoamericano para Arroz de Riego
FP	flagship program
GEM	Grain quality-enhancer, Energy efficient and durable Material
GLDC	Grain Legumes and Dryland Cereals CRP
GRiSP	Global Rice Science Partnership
IDO	Intermediate Development Outcome
IEA	Independent Evaluation Arrangement of the CGIAR
IF	impact factor
IITA	International Institute of Tropical Agriculture
IRD	Institut de recherche pour le développement
IRRC	Irrigated Rice Research Consortium
IRRI	International Rice Research Institute
ISC	Independent Steering Committee
ISPC	Independent Science and Partnership Council
JIRCAS	Japan International Research Centre for Agriculture Sciences
KII	key informant interview
M&E	monitoring and evaluation
MAB	marker-assisted breeding
MARLO	Managing Agricultural Research for Learning and Outcomes
MET	Multi-Environment Trial
NARS	national agricultural research system
NERICA	New Rice for Africa
NGO	nongovernmental organization
OICR	Outcome and Impact Case Report (part of annual reporting system of CGIAR)
PhilRice	Philippines Rice Research Institute
POWB	plan of work and budget (annual planning exercise at CRP)
PPMT	Program Planning and Management Team
PPP	public-private partnership
PVS	participatory varietal trial
QTL	quantitative trait locus
RCT	randomized control trial
RICE	Rice Agri-Food System CRP
SDG	Sustainable Development Goal
SLO	System Level Outcome
SPIA	Standing Panel on Impact Assessment of CGIAR
SRF	Strategy and Results Framework
STRASA	Stress Tolerant Rice for poor farmers in Africa and South Asia
STRV	Stress-Tolerant Rice Variety

TNAU	Tamil Nadu Agriculture University, India
ToC	theory of change
TOR	terms of reference
W1/W2	Window 1 or Window 2 funding
W3	Window 3 funding

Executive Summary

Background and Context on CRP

Rice farming is associated with several and deep structural challenges, such as diminishing availability of resources (land, water, labor, and energy), climate change, and inequality. The CGIAR Research Program (CRP) RICE aims to address such challenges. RICE is led by the International Rice Research Institute (IRRI) and five other organizations with international mandates. RICE is organized under five flagship programs (FPs): FP1–Accelerating Impact and Equity, FP2–Upgrading Rice Value Chains, FP3–Sustainable Farming Systems, FP4–Global Rice Array, and FP5–New Rice Varieties. RICE research is concentrated in five mega-rice growing environments: mega-deltas and coastal zones, irrigated systems, rainfed lowlands, uplands, and inland valleys.

Purpose, Scope, and Questions of the CRP 2020 Review

The purpose of this review is to assess the extent to which the RICE CRP delivered quality of science and demonstrating effectiveness in relation to its own theory of change during 2017 to 2019. The review questions, which were set by the CGIAR CAS, are as follows:

- **Quality of science**: To what extent does the CRP deliver quality of science, based on its work from 2017 through 2019?
- **Effectiveness:** What outputs and outcomes have been achieved, and what is the importance of those identified results?
- **Future orientation:** To what extent is the CRP positioned to be effective in the future, seen from the perspectives of scientists and of the end users of agricultural research (such as policymakers, practitioners, or market actors)?

Approach, Methodology, and Limitations

The methodology employs mixed methods. Qualitative and quantitative data were collected and combined in a process of triangulation to answer the three main review questions and all sub-questions. Key methods included analysis of program documentation and interviews with key RICE stakeholders. Forty-two interviews (including six women respondents) were conducted with RICE staff, partners, and donors. The review relied on evidence mainly from the CGIAR Dashboard and CRP datasets as external assessment data were limited. This is a rapid review, missing opportunities for in-depth data validation, field studies, and wider coverage.

Key Findings and Conclusions

RQ 1 – Quality of Science

The RICE CRP has access to sufficient quality, diversity, and quantity of skills, infrastructure/facilities, and collaborators (more than 400) across the globe, to deliver its objectives. Several RICE researchers have h-indices of 25 or more, indicating their international standing and high-quality contributions. RICE's leadership is strongly appreciated by researchers. A gender imbalance (highly skewed toward men) was evident among the RICE management staff (10 men:1 woman) and among senior research leaders (33 men:3 women). This imbalance was less evident among technical support staff (393 men:274 women).

The RICE partnership with CGIAR Centers, non-CGIAR institutions, and national agricultural research system (NARSs) is working well, as is evident from the co-authored publications, germplasm, and other outputs/innovations. Research planning and development of projects (in consultation with stakeholders) appears function smoothly. Flagship programs (FPs) are interlinked and deliver joined-up science and technologies following appropriate ethics and internal review mechanisms. Owing to staff losses, FP4 has suffered setbacks, especially on managing phenotyping activities; in the future this work can be better managed by merging it with FP5. RICE's efforts toward capacity development were found to be impressive, in terms of both number (training more than 500 scholars every year) and the quality and range of training opportunities offered (internships, on-the-job training, visiting scholars, BS, MS, PhD, and postdocs). However, NARSs still do not have the capacity to do such science on their own.

RICE generates a notable number of peer-reviewed journal articles (about 250 publications annually). According to this reviewer, 75% of these articles are of high quality and published in appropriate journals (in the fields of plant sciences, crop science, agronomy, soil, and engineering). Outputs reviewed showed high relevance to users, novelty, rigor, and originality. Some FPs or partners are delivering a better quality and quantity of research—for example, on average, 68% of RICE publications were generated by IRRI (FP1, FP2, FP5), 15% by AfricaRice (FP3), 7% by the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) (FP4), 5% by the Institut de recherche pour le développement (IRD) (FP4), 4% by the Centro Internacional de Agricultura Tropical (CIAT) (FP4), and 0.62% by the Japan International Research Centre for Agriculture Sciences (JIRCAS) (FP3). A pattern of association of 'publication in a high-quality journal' and 'winning bilateral funding' was seen for lead and other partners of the CRP. Interestingly, scientific outputs matched exactly with the funding allocated to them. About 30% of RICE papers published are not open access and not freely available to users.

RQ 2 – Effectiveness

The RICE CRP completed 79% of its planned milestones on time. This finding demonstrates effective planning and execution in the CRP. All flagships except FP4 have achieved most of their milestones in a timely manner. Insufficient finances and staff turnover are highlighted as reasons for noncompletion or delays in achieving milestones. Overall, RICE received 12% less funding during 2017 to 2019 than planned in its plans of work and budget (PoWBs) and 17% less than planned in its 2016 proposal. Facing budgetary uncertainty, all flagship budgets saw reductions. In the PoWBs for 2017–19 FP2 was allocated a small proportion (6%) of the total budget (US$230 million) and actually received 4% of total expenditure. Similarly, FP3 was allocated 28% of the total budget in the 2016 proposal (which was revised to 18% in the PoWBs) but received 20% of total expenditures. Lower planned allocations and lower actual expenditure than planned have compromised scaling-out activities in FP2 and FP3, potentially limiting the RICE's achievements. Despite these budget cuts and uncertainties, the RICE CRP has demonstrated stellar performance in discovery and delivery of science in rice agri-food systems. While a few innovations have achieved wide-scale application (such as NERICA, WITA9, *sub1*, satellite-based rice monitoring, smart valleys), adoption levels for several RICE innovations are still weak. This result indicates that the seed system work requires greater attention than what has been possible.

It is estimated that RICE impacted more than 2 million farmers during 2017–19 (the legacy impact could be around 10.4 million farmers over the Global Rice Science Partnership [GRiSP] period). This is about 20% of the target of 11 million affected that RICE wanted to achieve by 2022. Many of the technologies and innovations contained in Outcome Impact Case Reports (OICRs) are in the pilot or scaling phases. Several barriers to adoption and impact have been experienced, such as the limited capacity of the public sector and limited engagement with the private sector, especially in Africa. Further, affordability is a big issue for rice farmers regarding adopting several RICE innovations. These barriers would need to be overcome for RICE to improve its impact.

RICE leadership and continuity at the helm are widely acknowledged by several scientists to be the CRP's main driver of success. However, there is a perception that RICE lead center (IRRI) could have done more to enable and recognize good work, foster efficient internal structures (rather than duplications), and facilitate smooth execution of work. The role of the Independent Steering Committee (ISC) was particularly appreciated for providing regular recommendations to flagship leaders.

RICE realized the need for cross-CGIAR partnerships with A4NH, CCAFS, and PIM in several areas of collaborative research on nutrition, climate change and policy uptake, respectively. While partnerships (cross-CGIAR) worked in some instances, several RICE scientists consider this a missed opportunity.

RICE's theories of change (at the CRP and FP levels) are logically structured around four levels of impact pathways: discovery research, product, adoption, and outcome. RICE has achieved significant progress on TOCs at the CRP and FP levels, though more would need to be done in terms of scaling up RICE innovations. However, the RICE CRP has not used ToCs for program reflection and reporting. In most cases, impact evaluations of RICE work on different aspects (such as material, management technologies, tools, policy influence) are led by FP1, with participation and advice from external stakeholders. This peer review and evaluation system raises the prospect of (perceived or real) conflict of interest.

RICE has developed hundreds of quantitative trait loci (QTLs) or genes, models, products, and technologies that have good potential for achieving climate adaptation and resilience and contribute to climate change mitigation as well. The RICE CRP has demonstrated its gender inclusiveness across all flagships, though the limited resources available in FP2 and FP3 are likely to have contributed to lowering expectations around gender mainstreaming work. Youth programming in RICE is still nascent.

RQ 3 – Future Orientation

RICE, with IRRI, AfricaRice, and other partners, is well situated to progress strongly into the future in terms of its future funding pipeline and its reputation for credibility. A major risk RICE will face in the future is shifting donor priorities away from cereal crops to larger integrated development research and innovations to address grand challenges facing humanity (climate change; malnutrition; Covid-19, other pandemics, and pandemic-induced poverty and hunger; sustainable intensification). Addressing these challenges would continue to require RICE research and upscaling of RICE innovations.

Recommendations

For the RICE CRP

1. RICE should continue to strengthen its work on seed systems, with a dedicated team and partnership network. Investments in this area should be at least doubled in the future.
2. To the extent feasible within the remainder of the CRP timeframe, all Centers (including non-CGIAR centers) should mobilize funds and capacities to the CRP and close the gaps between differences in research outputs (publications) and bilateral funding delivered by Centers part of the CRP.
3. RICE should analyze mechanisms for its innovations to be taken to the scaling pathways. Several strategies for doing so are recommended in the detailed recommendations.
4. RICE programming can better frame its sustainable intensification work. To the degree feasible in the remainder of the CRP timeline, RICE should increase its research on sustainable production trade-offs.
5. An in-depth, independent review of private sector engagement in RICE for scaling up and adoption can be carried out to guide engagement models for achieving wider adoption and deeper impact.
6. ToCs at the CRP and flagship levels are, by their very nature, generic. While these are helpful, project-specific ToCs could be more granular and useful for tracking progress and identifying barriers along the ToC.
7. RICE should engage external team leaders in significant impact areas being assessed. This can provide more accountability and given CGIAR donors confidence about impacts being achieved.
8. In its 2020 annual reporting, RICE should consider capturing an extended summary of achievements and gaps related to the ToCs, at both the CRP and FP levels.
9. Improving the quality of science at the CRP would mainly require three interventions: (1) a gender-balanced ratio in staffing, (2) more open-access publications, and (3) a merger of FP4 and FP5, which would likely increase synergy and efficiency in operation.

For the CGIAR System

1. Greater CRP effectiveness is possible with better integration and a common framework of operation across CRPs and Centers. One CGIAR should promote an approach of less entrenchment and more collaboration, especially among CGIAR centers and between developing-country NARSs and CGIAR Centers. Further One CGIAR should infuse private sector thinking.
2. The System Organization (SO) should clearly lay out the functions of the Independent Steering Committee, which are aligned with Center-level structures.
3. CAS should develop a project evaluation system within CGIAR. In the One CGIAR system, an independent entity can take on this role of commissioning project evaluations of significant bilateral projects. These evaluations should be utilization focused.
4. CGIAR System Organization would need to review Managing Agricultural Research for Learning and Outcomes (MARLO) for its complexity and usefulness among the Centers and programs that have adopted it.
5. CAS (Evaluation Function) should complement the work of the Standing Panel on Impact Assessment of CGIAR (SPIA) by supporting CRPs in structuring impact evaluation systems led by external experts, especially for significant impact areas.

1 Background to the CRP 2020 Review

1.1 Purpose and Target Audience of the Review

The purpose of the RICE CRP review is to "*assess the extent to which the RICE research program is delivering quality of science and demonstrating effectiveness in relation to its own theories of change*."

Key objectives are:

- To fulfill CGIAR's obligations around accountability regarding the use of public funds and donor support for international agricultural research
- To assess the effectiveness and evolution of research conducted through the CRP in 2017–21
- To provide an opportunity for programs under review to generate insights about their research contexts and programs of work, including lessons for future CGIAR research modalities.

The study is accountability focused, but where lessons are identified these will be noted. Primary review users will be the CGIAR System Council, with additional potential for the RICE program management to draw on the insights and lessons. Additionally, the lessons may inform the One CGIAR transition in 2022. The findings, conclusions, and recommendations aim to inform the CRP as it refines its 2021 plan of work and budget for the remaining program year.

1.2 Overview of the CRP and Its Context in Research for Development

Rice is the world's most important staple food and will continue to be so in the coming decades. A staple food for some 4 billion people worldwide, rice provides 27% of calories in low- and middle-income countries. Global demand for rice is predicted to continue to grow in the time to come. With expected population growth and income growth global demand for rice will increase from 479 million tons of milled rice in 2014 to 536–551 million tons in 2030. Rice farming is associated with poverty. About 900 million of the world's poor depend on rice as producers or consumers, and of these, some 400 million poor and undernourished people are engaged in growing rice, mostly on landholdings of less than 2 hectares. Rice farming is also associated with several and deep structural challenges, such as the following:

- Environmental quality is declining worldwide, with diminishing availability of resources (land, water, labor, and energy).
- Climate change is exacerbating the situation through the effects of higher temperatures, more frequent droughts, and flooding, as well as sea-level rise, which threatens rice production in mega-deltas.
- Women still face many barriers and inequality in access to and control over resources such as land, information, and inputs.

Apart from increasing production and productivity, there is a growing demand that rice cultivation be done in a more environmentally friendly manner, combining genetic traits and cultural methods in such a way that poor farmers growing the crop have improved livelihoods and rice consumers gain better health and nutrition.

The CGIAR Research Program (CRP) RICE aims to address such challenges. As captured in the revised CRP proposal (RICE, 2016), RICE aims to facilitate transition of smallholder rice farmers to modern business entrepreneurship by exploiting opportunities offered by market diversification and the emergence of stronger consumer demand for high-quality and nutritious rice products. At the same time, it is helping poor farmers in hinterlands and less-endowed environments cope with extreme stresses and the effects of climate change and other shocks. In doing so, RICE is at the cutting edge of science, mobilizing modern technological breakthroughs such as those offered by biotechnology, information and communication technology (ICT), and Big Data platforms. The revised proposal says that the RICE will harness 600 research and development partners from both the public and private sectors to deliver measurable impacts on the overall goals of the CGIAR: reduced poverty, improved food and nutrition security, and improved natural resources and ecosystem services. With appropriate technological, institutional, and policy support, rice farming, processing, and marketing could offer equal opportunities of employment for women and men and help to empower women, thus accelerating attainment of food security and poverty alleviation.

The RICE CRP is implemented by six organizations with international mandates and a large portfolio on rice: three members from the CGIAR—the International Rice Research Institute (IRRI, the lead institute), Africa Rice Centre (AfricaRice), the International Centre for Tropical Agriculture (CIAT)—and three other leading international agricultural agencies: Centre de Cooperation lnternationale en Recherche Agronomique pour le Développement (Cirad), L'lnstitut de Recherche pour le Développement (IRD), and the Japan International Research Centre for Agricultural Sciences (JIRCAS). 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
- 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.

RICE is organized under five flagship projects (FPs) and several clusters of activities (CoA) within each FP:

FP1–Accelerating Impact and Equity: FP1 has several research and development priorities expressed as CoAs related to foresight and targeting; gender and youth; collective innovation and scaling out; seed delivery systems; adoption and impact assessment; and monitoring, evaluation, and learning.

FP2–Upgrading Rice Value Chains: FP2 has several research and development priorities expressed as CoAs related to value chain and market research, value chain services and finance, improved post-harvest systems, rice processing, and new products.

FP3–Sustainable Farming Systems: FP3 has several research and development priorities expressed as CoAs related to farming system analysis, intensification and mechanization, and farm diversification.

FP4–Global Rice Array: FP4 has several research and development priorities expressed as CoAs related to a worldwide field laboratory, global phenotyping, genetics of rice plant interaction with the biotic environment, discovery of genomic associations, and big data integration platforms.

FP5–New Rice Varieties: FP5 has several research and development priorities expressed as CoAs related to harvesting rice diversity, precision breeding, intensive systems, unfavorable ecosystems, grain quality and nutrition, and modernizing rice breeding.

Each RICE CoA has specified a number of action sites or countries where the research is focused. Some of the upstream research is not particularly location dependent (e.g., gene discovery); however, all downstream research and development activities are concentrated in five mega-rice growing environments: mega-deltas and coastal zones, irrigated systems, rainfed lowlands, uplands, and inland valleys.

1.3 Scope of the Review and Review Questions

This review focuses on the work of RICE and its flagship programs, guided by the theory of change (ToC). The emphasis is on aspects under RICE's sphere of control—i.e., the quality of inputs, activities, and outputs, and influence that constitute short-term and intermediate outcomes that are anticipated to lead to development impact. The review questions, which were set by the CGIAR CAS, are as follows:

- Quality of science: To what extent does the CRP deliver quality of science, based on its work from 2017 through 2019?
- Effectiveness: What outputs and outcomes have been achieved, and what is the importance of those identified results?
- Future orientation: To what extent is the CRP positioned to be effective in the future, seen from the perspectives of scientists and of the end users of agricultural research (such as policymakers, practitioners, or market actors)?

1.4 Approach, Methods, and Limitations

The methodology employs mixed methods. Qualitative and quantitative data were collected and combined in a process of triangulation to answer the three main review questions and all sub-questions. No additional review questions were identified by RICE management. All CRPs have a (nested) ToC and associated Intermediate Development Outcomes (IDOs) that contribute to the CGIAR overall Strategy and Results Framework (SRF) and System Level Outcomes (SLOs). The nested ToCs (i.e., at the RICE CRP level and FP level) are analyzed as part of the review, providing a guide to assessing effectiveness.

As well as review questions on the quality of science and effectiveness, the analysis indicates an estimation of CRP potential up until the end of the CRP (2021), foreseen and unforeseen outcomes and impacts beyond program timeframes, and the CGIAR One transition period. Key methods included analysis of program documentation and interviews with key RICE stakeholders. Forty-two interviews (including six women) were conducted with RICE staff, partners, and donors (see Annex 4). Interview checklists varied according to the role of the interviewee (see Annex 5).

CGIAR Dashboard data were pre-analyzed by the CAS Secretariat, which provided a bibliometric analysis and statistics on policies, innovations, milestones, and Outcome Impact Case Reports (OICRs). Primary sources of data include RICE documents; semi-structured interviews with RICE management and staff, donors, and partners; staffing and financial resources; annual reporting data (2017–19), including the online information management system (Managing Agricultural Research for Learning and Outcomes [MARLO]) and CGIAR Results Dashboard; OICRs; selected peer-reviewed journal articles; and bibliometric studies.

The quality of science (QoS) assessment focused on the quantitative measures of inputs (e.g., gender, domain, age, and other profile parameters of staff members working on the CRP), including the depth and breadth of research staff skills and diversity. The quality of processes is analyzed based mainly on interviews with RICE management and partners. The assessment of outputs is based on quantitative review of the bibliometric analysis (journal articles, including impact factor rankings for journals, collaborations, and keywords to assess the breadth and impact of publications). Additional QoS analysis in selected publications is found in Annex 6.

Assessment of effectiveness is based, first, on an analysis of achievement of milestones against those planned (see also Annex 7); second, on an analysis of OICR deep dive studies (see also Annex 15); and third, on an analysis of diverse sources of evidence assembled to test the program theory of change (see also Annex 10). Management and governance are assessed through a review of financial reports, especially use of window 1 and 2 (W1/W2) funds; reports from the Independent Steering Committee (ISC) meetings and members; and interviews with RICE leaders, staff, and partners. Direct use of data from the CGIAR Dashboard (including CAS pre-analyzed CGIAR Dashboard data), as well as interviews with FP project and CoA leaders, informed the assessment of effectiveness and analysis of the reporting system. Analytical methods include content analysis and synthesis of findings.

Limitations: The review relied on evidence mainly from the CGIAR Dashboard and CRP datasets; limited external assessment data were available in terms of evaluations commissioned by the Standing Panel on Impact Assessment of CGIAR (SPIA) or project-specific evaluations. The review as a theory-based evaluation is limited by the fact that annual reporting and other forms of data documentation are only partially based on TOC. By design, this rapid review did not include in-depth data validation, field studies, and wider coverage of key stakeholders across geographies and FPs.

1.5 Management and Quality Assurance

The review team, working collaboratively, was composed of the subject matter specialist, Dr. Rattan Yadav (leading on the quality of science aspect of the review) and the evaluation specialist, Associate Professor Ravinder Kumar (team leader). The CAS Secretariat managed the review, providing oversight through regular check-ins and collection of quality assurance metrics regarding progress. A peer reviewer gave feedback on preliminary findings via an online session. The preliminary findings were shared with the CAS Secretariat and with the RICE team. A draft report was shared with CAS, the peer reviewer, and the RICE Program Planning and Management Team (PPMT) for feedback and factual corrections.

2 Findings

2.1 Quality of Science

2.1.1 Quality of Research Inputs

IRRI, RICE CRP lead, employs the CRP director, and a program manager who supports the director, for day-to-day management. This review found that the program has access to a full range of needed skills (ranging from natural sciences to social sciences), infrastructure (laboratory and field sites), and collaborating institutions (more than 400 partner organizations) for it to develop and test novel science and technologies. Interviews with a sample of individual team members of RICE working across the five FPs confirmed that that the funding and infrastructure they need was fully met by the program and they did not feel any constraints in meeting their objectives. Examination of RICE's budgetary allocations revealed (Annex 6.2) that IRRI is the dominant partner of the CRP, getting largest proportion (76%) of its total budget (Figure 1), followed by AfricaRice and CIAT. All CRP partners[1] are winning bilateral projects[2] (e.g., AfricaRice: 29; CIAT: 19; IRRI: 192; CIRAD: 16; IRD: 10) and contributing to the RICE budget portfolio. In line with budget allocations, IRRI employed the greatest number of staff, followed by AfricaRice and CIAT. IRRI leads three of the five RICE flagships (FP1, FP2, and FP5), and the other two are led by AfricaRice and CIAT each (Annex 6.2). All five FPs are designed in such a way that they are interlinked and there is clear flow of communication and information across them. Some staff were employed across the FPs (notably FP4 and FP5), further integrating the program. The RICE senior staff team was found to be diverse in terms of nationalities and skills/expertise, as reflected in the multidisciplinary outputs they deliver (Annex 6.3). In terms of gender, IRRI staff of RICE was highly skewed toward men, especially at the senior research and managerial levels (Table 1; Annex 6.2). For example, RICE leadership at IRRI (including flagship and CoA leaders) comprised 36 staff, of which 33 were men and 3 were women. Surprisingly, this ratio was less skewed among technical support staff supporting CRP's research leaders at IRRI (393 men versus 247 women). A similar gender imbalance was found at AfricaRice (11 men versus 1 woman) in senior leadership and managerial roles. In contrast to IRRI and Africa Rice, CIAT had a notable gender balance (4 men:4 women). The RICE PPMT was also found to be heavily skewed toward men (10 men:1 woman).

Figure 1: Proportion of RICE budget shared by RICE partners

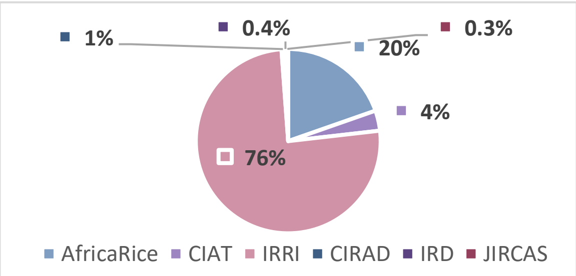


Table 1 Gender analysis of RICE leadership at three CGIAR partner Centers

Participating CG Center	Flagship leadership roles			Cluster of activity leadership roles		
	Total	Male	Female	Total	Male	Female
IRRI	3	3	0	16	14	2
Africa Rice	1	1	0	12	11	1
CIAT	1	0	1	8	4	4

2.1.2 Quality of Process (including Partnerships)

It was found that RICE partnerships between CGIAR Centers, non-CGIAR strategic partners, and national agricultural research systems (NARSs) were highly diverse and extensive, covering large parts of South Asia, Latin America, and Sub-Saharan Africa (Annex 6.8). These partnerships worked well, based on stakeholder analysis, and need assessment undertaken with key partners. In particular, NARSs overwhelmingly confirmed the advantages of strong partnerships with RICE and want them to continue. Further inquiry about the involvement of NARSs in RICE partnerships, however, confirmed that the NARSs were largely doing what they are told to do rather than appreciating the benefits they draw from such collaborations. This finding raised concerns about the fairness and equity of partnerships between

[1] Except JIRCAS
[2] Bilateral project data are for 2017 to 2019

NARSs and RICE and requires further in-depth analysis of what was missing in the partnership equation, which was beyond the scope of the current review. From the interviews conducted across NARSs, it was clear beyond doubt that the science and technologies that RICE is delivering are relevant to them. In general, RICE's partnerships were also contributing to capacity building (Annex 6.7). All partners are actively involved in capacity building of NARSs through the training of NARS scholars (at BS, MS, and PhD degree levels) and other end users and next stage users[3]. RICE is openly and extensively sharing technologies and germplasm with NARSs. OICR deep dive (see Annex 15) confirms this. RICE leadership (CRP director, RICE PPMT) encouraged collaboration across RICE flagships, which was evident from the publications that RICE is generating. Many OICRs generated by RICE also resulted from research carried out in more than one FP.

According to the RICE ISC meeting minutes, the ISC met regularly (annually as intended) and steered the program's research and technology development. The RICE PPMT appears to have met periodically. The RICE ISC, PPMT, and CRP leadership ensured that scientific credibility criteria were met by following good scientific practices. Conflicts of interest between researchers and partners were limited, confirming that mutual accountability between researchers and their partners was strongly developed. From the quality of the outputs RICE is delivering (see section 2.1.1.3), it was clear that RICE is applying appropriate rigor in developing and disseminating science to next-stage users. Poor translation of outputs from FP4 into OICRs was noted, and greater collaboration between FP4 and FP5 might assist translation of FP4 science into impact cases.

2.1.3 Quality of Outputs

2.1.3.1 Quantum of Research Outputs and Collaborations

RICE produces a wide variety of research outputs ranging from peer-reviewed journal articles to book chapters, proceedings papers, editorial material, news items, and reviews. CAS pre-analyzed CGIAR Dashboard data confirmed that 882 publications were published by RICE during 2017–19; of these, 811 were in International Scientific Index (ISI) journals. Of the articles in ISI journals, 733 were found in Web of Science, and these 733 research articles were analyzed in detail. These articles were contributed by 4,672 authors. Only 9 of these authors contributed single-authored papers, and the rest of the 4,663 authors contributed multi-authored documents. On average, 6.04 authors contributed per research article, and the collaboration index of authors was found to be 6.11, higher than the average (5.16) observed across CGIAR CRPs.

Table 2 shows a high volume of peer-reviewed articles published by RICE every year. Research papers produced by RICE were consistently around 250 per year. Analysis of publications per Center showed that IRRI contributed largest share (67.8%), followed by AfricaRice (15.3%), CIAT (4.1%), IRD (5%), and JIRCAS (0.6%). These shares are in proportion with the funding each of these Centers receives from RICE. Not all research articles published by RICE were open access; in fact, a good number of them (33.4%) were published in non-open-access journals. From the articles published during 2017–19, 40 were noted as having more than 10 citations each (Annex 6.6). Some articles had exceptionally high citations; 7 articles had more than 100 citations, and another 16 over had more than 40, which was impressive in the short span of a year or two from their publication. Three hundred and sixty-eight (47.6%) of the RICE research outputs were generated by the 25 most productive authors (Annex 6.4). Among the contributing countries, the Philippines (where IRRI is based) contributed to 215 of the 773 articles, which is 27% of total RICE publications (Annex 6.5). This was followed by France contributing 67 (8.7%), USA 61 (7.9%), India 49 (6.3%), China 47 (6%), Germany 38 (4.9%), Australia 35 (4.5%), and Japan 31 (4%).

Table 2 Volume and share of peer-reviewed RICE papers in open-access and non-open-access journals

Year of publication	Total publications	Number of papers published in non-open-access journals	% of papers published in non-open-access journals
2017	250	93	37.2
2018	246	80	32.5
2019	237	72	30.4

[3] Next stage users such as NARS, ARIs and end users such as producers, consumers

Total	733	245	33.4

2.1.3.2 Quality of Researchers and Research Outputs

Of 773 RICE research articles, 279 (36.1%) were published in 15 journals (see Annex 6.3). They covered a broad range of topics (genetics, agronomy, plant sciences, multidisciplinary sciences fields), and their impact factors (IFs) ranged from 2 to 8. All these journals were in top two quartiles for their categories. A good number (19.7%) of RICE papers from 2017–19 appeared in top journals (IF above 4.0), including *Nature* and *Science*. Ten of the RICE researchers had h indexes greater than 25, and another 7 had h indexes between 20 and 25 (Annex 6.4). About 20% of RICE researchers do not produce a large volume of outputs or outputs that are highly cited. A sample of 10 papers published from 2017 to 2019 (two from each FP, Annex 6.1) were randomly selected to assess their academic quality (rigor, originality, repeatability, significance to the field, interest to RICE audience, international public good). The analysis showed that the majority of these were world-leading high-quality work containing novelty and originality. Impressively, all of these showed high relevance and were of interest to the RICE community.

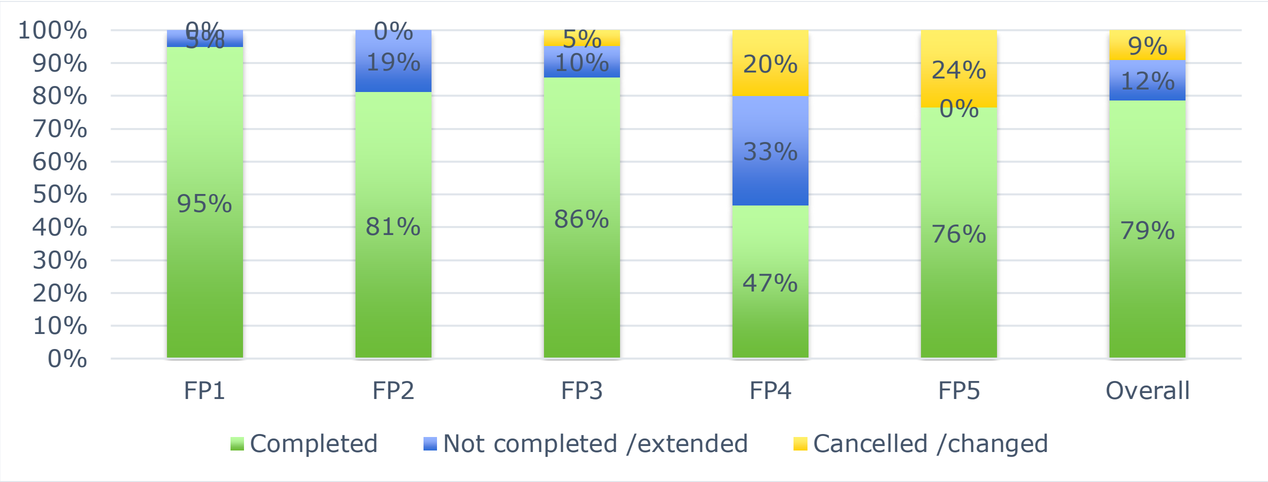
2.2 Effectiveness

2.2.1 Achievement of Planned Outputs and Outcomes

The RICE CRP completed 79% of its planned milestones on time, demonstrating effective planning and execution in the CRP. Twenty-two percent of milestones were extended or revised, and only 9% of milestones were canceled or changed, according to CAS pre-analyzed CGIAR Dashboard data, annual reports, and key informant interviews. All flagships except FP4 have already achieved most of their milestones. FP4 has achieved only 47% of its milestones on time, while 33% of milestones were extended and 20% of milestones were canceled or changed as a result of staffing and other internal challenges faced by the FP. Insufficient finances to complete a milestone have been cited as a reason for delay in several instances. In some cases, progress on a milestone was reportedly affected by a scientist leaving the job, such as the FP2 milestone related to upgrading strategies for diversified livelihoods.

Milestones tend to be formulated ambitiously and marked as complete without necessarily achieving the fuller stated intent. For example, one milestone marked as complete called for production of sufficient commercial seed for at least 5 million farmers, of whom at least 50% are women, at the key action sites (FP1, 2018). Progress reported on this milestone indicates that an estimated 43,200 farmers might have benefited from expected production of 1,080 tons of certified seeds—far from the 5 million farmers stated in the milestone. This pattern is observed across several other milestones marked as complete (see Table 4 in Annex 7). This necessitates a nuanced understanding of what is meant when milestones are marked as complete. In cases where multiple geographical sites are involved in a single milestone, RICE can extend the milestone until all geographical sites have achieved same status, as was done in case of the FP2 milestone related to upgrading value chain strategies in West and East Africa. Alternatively, RICE can split the milestone into several milestones for each site to track progress appropriately. Figure 2 shows milestone achievement by flagship.

Figure 2: Performance on 89 RICE milestones by flagship, 2017–19

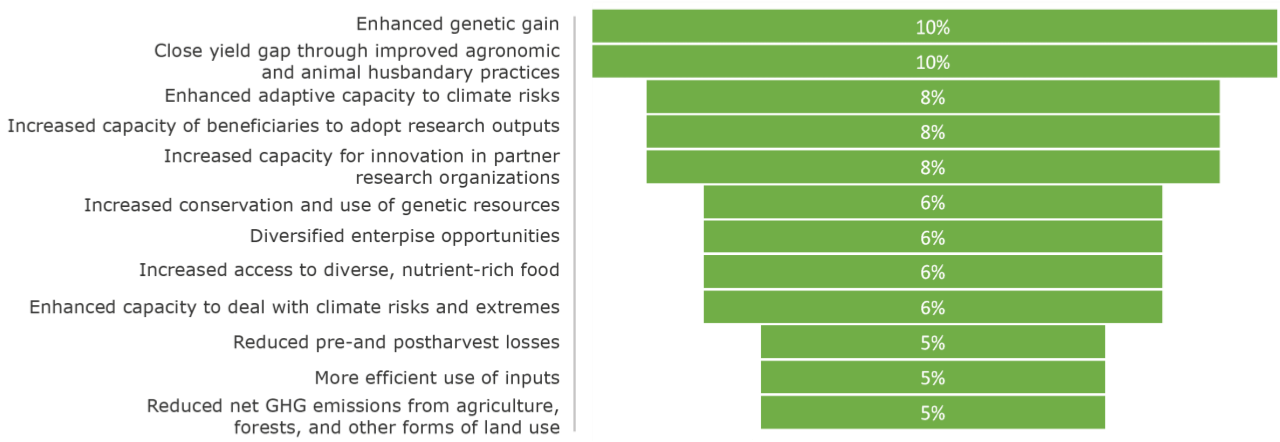


RICE milestones are linked with sub-IDOs, as several milestones completed together are likely to contribute to achievement of specific sub-IDO. An indicative analysis of this linkage of milestones with sub-IDOs suggests that the two most important sub-IDOs that CRP milestones contribute to are:

- **Enhanced genetic gain** (FP4 and FP5): 10% of all milestones (89) in RICE contribute to this sub-IDO;
- **Close yield gap** through improved agronomic and animal husbandry practices (FP1, FP3, FP4, FP5): 10% of all milestones in RICE contribute to this sub-IDO.

Figure 3 shows significant sub-IDOs toward which RICE milestones contribute.

Figure 3: Percentage of milestones contributing to a sub-IDO

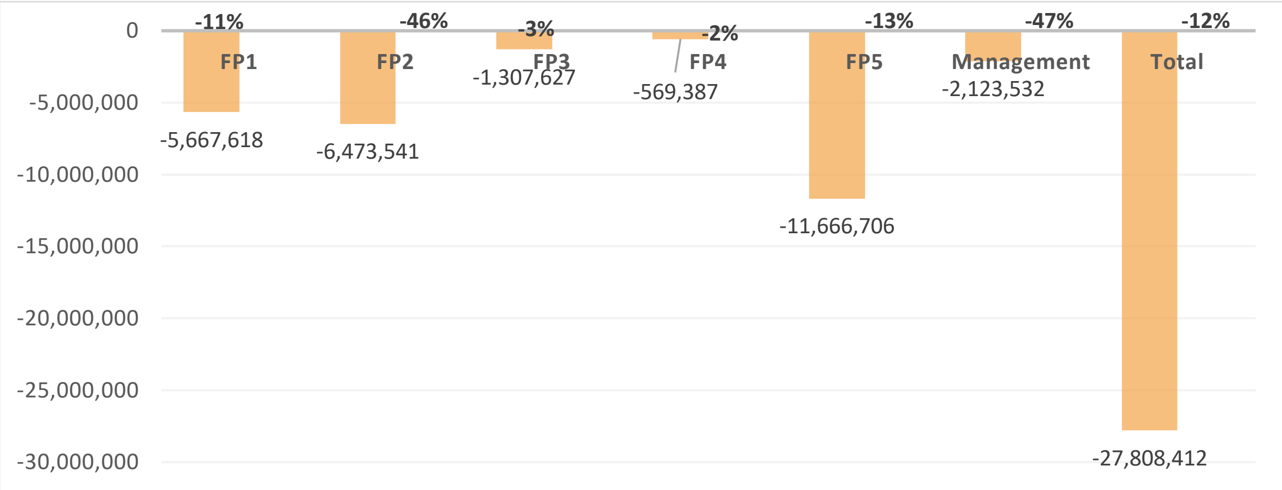


Milestone planning and achievements are a function of budgetary allocations and associated certainties. The RICE annual plan of work and budget (POWB) was affected by budget cuts and associated uncertainties, especially related to W1/W2 budgets. Every year, the RICE management team carried out a reallocation exercise based on estimates of what was likely to be available. This review carried out a summary analysis of FPs' actual expenditures as reported in annual reports compared with what was planned in the 2016 revised proposal and in annual POWBs during 2017–19. Overall, RICE received 12% less funding than planned in the POWBs and 17% less than planned in the 2016 proposal. Facing budgetary uncertainty, all FPs' budgets saw reductions. FP2 was allocated a small proportion (6%) of the total budget (US$230 million) in the POWBs during 2017–19, but it received 4% of total expenditures. Similarly, FP3 was allocated 28% of total budgets in the 2016 proposal (which was revised to 18% in the POWBs), but in reality FP3 received 20% of total expenditures. **Lower allocations[4] and lower actual**

[4] When POWBs are compared with 2016 proposal.

expenditures than planned[5] have compromised upscaling activities in FP2 and FP3, potentially limiting the achievements of RICE. With the declining W1/W2 budget, research lines on collective innovation and seed systems have been deprioritized. Instead of initiating new research on seed systems, RICE used the limited budget available to wrap up pending manuscripts for submission to peer-reviewed journals. The FP also gave priority to research funded through existing bilateral projects (information based on annual reports, POWBs, the 2016 proposal, CGIAR Dashboard, and KIIs).

Figure 4: Actual RICE expenditures compared with budgets in POWBs, 2017–19



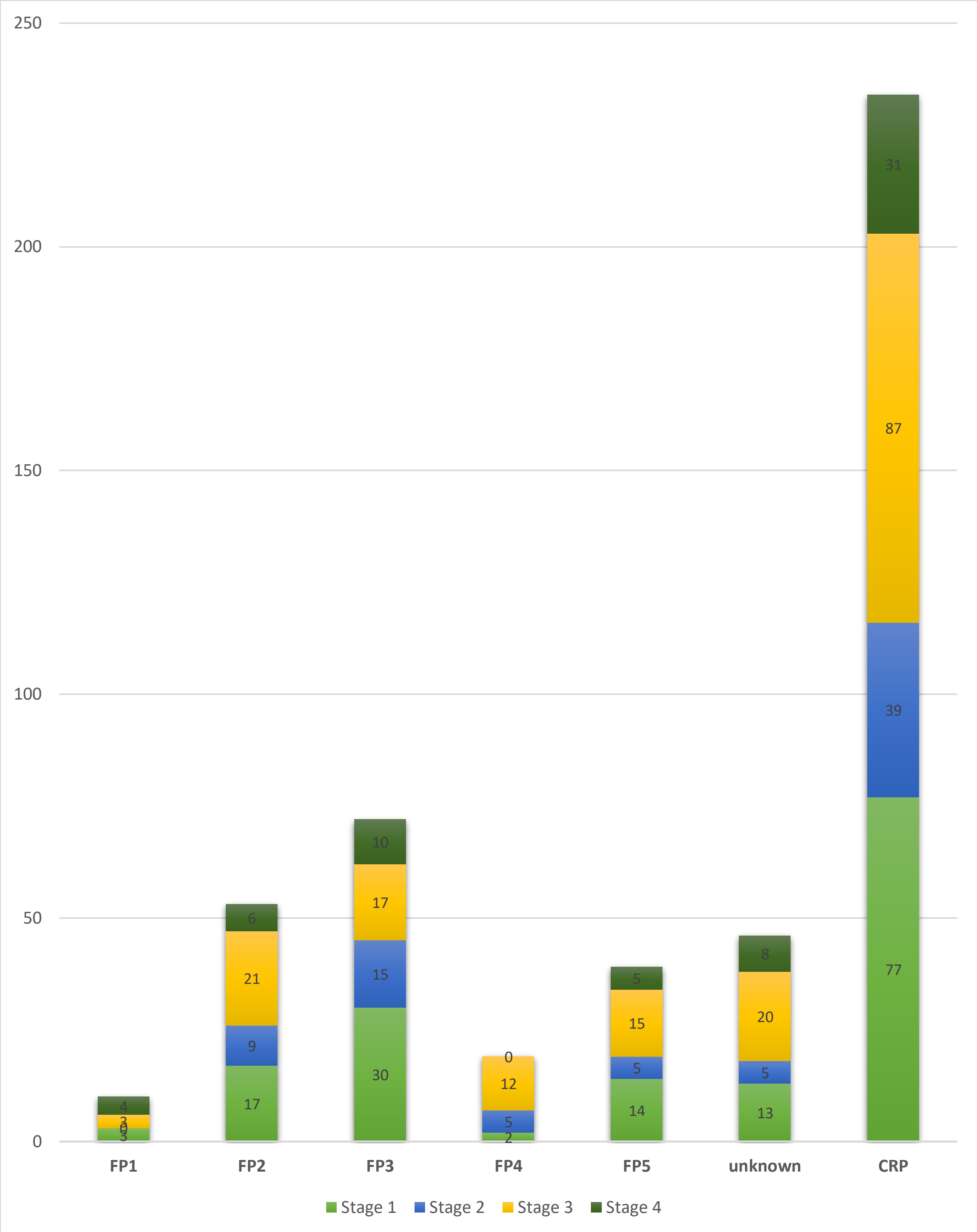
Despite the budget cuts and uncertainties, **RICE CRP demonstrated stellar performance in the discovery and delivery of science** in the rice agri-food system during 2017–19. RICE has built on its GRiSP legacy and continued to deliver credible science. It has hundreds of product lines coming out every year. Fifty-two percent of RICE innovations are in stage 1 or 2, while 48% of innovations are in stage 3 or 4—that is, ready for uptake or uptake by next users. While **a few innovations have achieved wide-scale application** (such as NERICA3, WITA9, *sub1*, satellite-based rice monitoring, smart valleys), there is strong recognition among scientists on the need to disseminate faster. However, **adoption levels for several RICE innovations are still weak**. Alternate wetting and drying (AWD), for example, has not been adopted widely in farmers' fields in Bangladesh, though performance is much better in Vietnam. Similarly, several new varieties have seen low adoption so far; for example, a submergence-tolerant variety has not been widely adopted by farmers in India (Assam) and Bangladesh. This could be due to an inaccurate understanding of the nature of stress when developing the variety or to technical difficulties in developing a variety (KIIs, OICRs).

Scientists expressed a strong need to disseminate innovations faster for achieving wider uptake (KIIs). Dissemination would require stable and sturdy partnerships along the lines being fostered by seed systems work in FP1 and FP2. However, seed systems work would require greater attention than what has been possible within existing arrangements of flagships, CoAs, and funding allocations. Seed systems in Africa are rudimentary, and RICE so far has managed to achieve impact on a small scale. This is a work in progress, and better understanding of farmers' field scenarios in different contexts is needed, along with higher investments in developing better varieties and scaling mechanisms for them (KII). Among the FP1 and FP5 risks identified at the beginning of the RICE CRP was a weak program for national seed systems with limited involvement of the private sector. Since then FP1 and FP5 have strengthened seed systems and delivery efforts. RICE is now working with 20 partners—half national agricultural research and extension systems (NARESs) and half private see companies—for seed delivery in South Asia (Bangladesh and India) and Africa (Burundi, Kenya, Mozambique, Tanzania, and Uganda). Similar work is happening in West and Central Africa through the African Development Bank (AfDB) project (W3) mapped to the CRP and led by AfricaRice (Benin, Burkina Faso, Central African Republic, Côte d'Ivoire, and Nigeria). This now connects the RICE impact pathway, from the release of improved germplasm, through NARESs and in partnership with national private seed companies, toward the release of quality seeds to farmers (KIIs). This arrangement would need to work effectively in several countries

[5] When actuals are compared with the POWBs as well as 2016 proposal allocations.

in Africa and in some countries of Asia to provide the needed push toward better adoption and impact of RICE innovations.

Figure 5: Number of RICE innovations (n=224) by innovation stage, 2017–19



1 = discovery/ proof of concept	2 = Successful piloting	3 = Available / ready for uptake	4 = uptake by next user

2.2.2 Demonstrated Importance of Outcomes and Contribution of Outcomes to Broader Goals

End users of RICE CRP products are millions of rice value chain actors such as farmers, millers, processors, traders, and consumers. Based on annual CRP reports (2017–19), it is estimated that **RICE has impacted additional more than 2 million farmers** (its legacy impact could be around 10.4 million farmers over the GRiSP period). This is about 20% of the target of 11 million farmers that RICE wanted to achieve by 2022.

RICE adoption and impact analysis (from several studies as referenced) have largely established that if RICE products are consistently adopted, the benefits are significant in terms of productivity (generally estimated as a 0.5–3 tons per ha increase) and profitability (additional income of US$100–300 per ha). **The challenge is in scaling up RICE innovations, including mainstreaming within government policies and successful commercialization by private sector.**

Adoption of RICE innovations and technologies is reported mainly across West Africa and Southeast Asia.[6] As can be seen in Figures 6 and 7, OICRs and policy influence are less reported in other countries of Sub-Saharan Africa. Clearly, there are countries and regions where RICE would need to make greater inroads into policy circles to contribute to broader goals of poverty reduction and food and nutrition security.

RICE has achieved strong policy engagement in select African and Asian countries. Influence in **Africa was achieved through regional frameworks or platforms** such as the Coalition for African Rice Development (CARD), the Economic Community of West African States (ECOWAS), and AfricaRice, while **influence in Asia was achieved through specific country-level policy engagement**, with Vietnam, the Philippines, India, and Bangladesh cited as good examples (KIIs, annual reports). The Philippines and Vietnam are the standout examples of country-level policy influence as several instances of success is available there. The FP3 team has helped establish a rice sector platform for building incentive mechanisms for sustainable production in Vietnam. Improved rice management practices that reduce greenhouse gas emissions have been demonstrated in Vietnam. Promising research areas have been significantly expanded in the Philippines—for example, the Department of Agriculture funded a project on sustainable rice straw management for scaling up mechanized rice straw collection. (see Annex 8 for more policy analysis).

Figure 6: Representation of countries among 42 OICRs reported in the RICE annual reports, 2017–19

[6] It is no coincidence that AfricaRice and IRRI are in West Africa and Southeast Asia, respectively, as location seems to matter.

The CRP documented 42 OICRs in three annual reports (2017, 2018, and 2019) (Figure 6; Annex 10). In several OICRs (especially level 3 ones), the evidence demonstrates what RICE has contributed to the broader goals, but in several other OICRs (level 1 or 2), evidence does not fully reflect outcomes (and consequently broader goals) being achieved at scale. Many of the technologies and innovations contained in OICRs are in the pilot or scaling up phases. Only six OICRs (14% of 42) presented in the last three years are at level 3, meaning that policy and/or practice changes are influenced by these outcome cases, leading to impacts at scale or beyond the direct CGIAR sphere of influence. An in-depth analysis of evidence presented across OICRs indicates that several RICE technologies continue to need better strategies and more investments to increase the level of adoption and impact being achieved (see Table3; see Annex 10 for more OICR analysis). This review has done deep dives on two selected OICRs (Annex 15).

Figure 7: Regions where RICE has informed or influenced policies (n = 25), 2017–19

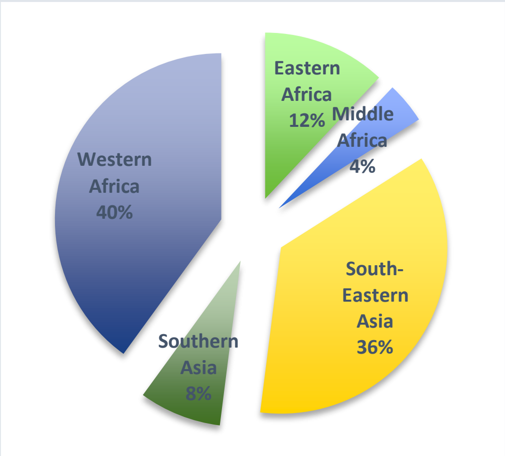


Table 3 Analysis of outcomes (as reported in the OICRs) contributing to broader goals

Outcome and Impact Case	Reported impact evidence by OICRs	Reviewer's remarks
Satellite-based rice monitoring system (2018) Remote sensing–based rice insurance in Tamil Nadu, India (2017; updated 2019)	A total of >300,000 farmers received timely crop insurance payouts in Tamil Nadu under the central government insurance program in the 2016–17 Samba season; preventive sowing payout received by 47,513 farmers. The impact of this RICE innovation continued to accrue during 2017–19. Based on the deep dive, it is known that remote sensing-based rice insurance has generated large benefits for close to 300,000 farmers on an annual basis. Government of Tamil Nadu stipulated that all insurance companies use the data provided by the RICE partner (Tamil Nadu Agriculture University [TNAU]).	This OICR presents a remarkable contribution that can be considered one of RICE's most significant innovations, especially as remote sensing–based rice monitoring in several countries is leading to improved climate resilience and adaptation. It has been taken to scale in India and the Philippines and is developing well in Cambodia and Vietnam. RICE is exploring replication in India (such as in Bihar, Orissa, and Andhra Pradesh) and in other countries (such as Bangladesh), and prospects are strong. There is also potential for this RICE innovation to be adapted to other agri-food systems such as groundnuts and pulses. RICE should continue to prioritize its work on this area and support further upscaling and impact. Given the high significance attached to this initiative, RICE should annually publish an open-access paper giving updates on achievements and challenges across the countries where it is being replicated. For more analysis on this OICR, see Annex 15.
Expansion of the "seeds without borders" agreement with Bhutan (2018)	Bhutan can now import improved variety seeds without much hassle from six countries in the region. Bangladesh, Cambodia, India, Myanmar, Nepal, and Sri Lanka are the other members of the network agreement.	This is a remarkable policy success where RICE has made strong contributions over the years. This shows that policy success comes with credibility, a collaborative approach, and consistency of engagement over many years.
Adoption of flood-tolerant rice varieties in Bangladesh (*sub1*) (2018)	In the 2017–18 Boro/dry season, 2.1 tons of improved seeds and stress-tolerant rice varieties were distributed to 500 farmers. In the 2018 Aman/wet season, 6.7 tons of improved seeds and stress-tolerant rice varieties were distributed to more than 1,500 farmers. These varieties are making a significant impact on farm income, food security, and livelihoods of rice farmers in Bangladesh.	Predicted probability indicates that 40% of farmers have adopted *sub1* rice. This figure is difficult to verify; interviews with NARSs in Bangladesh and India indicate that *sub1* rice is widely adopted, but they doubt whether adoption has reached 40%.
Solar bubble dryer (SBD)—a novel and low-cost drying technology commercialized and marketed globally (2019)	Current models have 0.5-ton and 1-ton batch capacity. The first version of the SBD was commercialized in September 2014, and currently 508 units have been sold by GrainPro worldwide.	An SBD with a 4- to 5-ton dryer capacity is likely to fare better as it can better address farmers' needs. RICE is working with GrainPro to develop this higher-capacity dryer, which is likely to have far better utility and scalability. R&D on this is ongoing, and commercial pathways are being developed.
Commercialized hermetic Super Bag for safe storage of rice grains and seeds (2019)	The IRRI Super Bag allows farmers and processors to hermetically store cereal grains and other crops (e.g., maize or coffee). The Super Bag has been shown to extend the germination life of seed by 6–12 months, control pests (without using chemicals), and improve the head rice recovery of stored grain typically by 10%. The Super Bag, with 50-kg capacity, is commercialized globally. Intended users are farmers and seed producers.	The Super Bag is a big commercial success, less for rice but more for specialty coffee. GrainPro sells 5 million bags annually, largely for coffee, chilies, and other high-value crops. Farmer producer organizations or farmer cooperatives and collectives may have an interest in investing in this solution for making collective storage and marketing more relevant (and affordable) for rice farmers.

RICE has realized the need to **work with the private sector to disseminate new varieties in the absence of** public systems to disseminate new varieties in many countries. The CRP has engaged with the private sector in terms of offering intellectual property rights (IPR) or other incentives. This is one enabler of CRP success in countries such as India, Bangladesh, the Philippines, and Vietnam (KIIs, OICRs, annual reports). NARSs and NARESs are key RICE partners for scaling, but different countries have different capacity development needs. While several capacity development actions have taken place, it is not evident whether these were based on a **holistic understanding of the capacity barriers for achieving success in scaling in different NARSs.** For example, as a technical collaboration, **NARSs in Africa expect a hands-on capacity development approach** from the RICE CRP while the NARSs in Bangladesh or India expect a continued relationship with RICE to facilitate increased government or donor investments in building infrastructure and national capacities. One of the enabling actions proposed in the RICE ToC is that "RICE would adopt the CGIAR capacity development framework as a comprehensive structure to systematically strengthen capacity among partners and actors along its impact pathway." The critical thinking and actions on the CGIAR capacity development framework for different countries is not reflected in RICE annual reports or other specific documents.

Affordability hinders farmers' adoption of several RICE innovations, such as the hermetic Super Bag, the bubble dryer, and AWD. Even when solutions are brilliant, farmers face several hindrances in adopting technologies. A farmer is in business to generate a return, with a time lag in investments and considerable uncertainties. At harvest time, prices are extremely low as everyone harvests, but two to three months later a substantial price increase is possible. However, smallholders do not have money to store rice (or other crops) for three to four months waiting for prices to go up, so they tend to sell their harvest right away and get low prices. This is a circle of poverty with seemingly no way out. These **constraints in the economic model would need to be addressed for postharvest technology** to be taken up by the farmers.

2.2.3 CRP Management and Governance

The effectiveness of CRP governance and management is driven mainly by two factors (apart from size of funding and enabling context): (1) quality of CRP leadership and (2) quality of fostering by the IRRI, the lead center.

An all-round appreciation for the quality of CRP leadership is heard by the review team (KIIs). RICE leadership and continuity at the helm are widely acknowledged by several scientists to be the main driver of the success of the CRP. CRP leaders have acted deftly in bringing CGIAR and non-CGIAR centers together and in ensuring that tension between programs and teams across Centers is managed constructively. Leadership provided the vision and supportive supervision and direction to the team to perform at their best. Leadership also handled budget cuts and budgetary provisions across Centers and FP teams very well. The leadership was appreciated for its fairness and transparency in all these matters, which established the trust that is so crucial in a global and complex program.

While interviewees expressed appreciation for the quality of IRRI's fostering of RICE, it was perceived as less close-knit than was the case in GRiSP. **There is a perception that IRRI, as the lead, could have done more to enable and recognize good work, foster efficient internal structures (rather than duplications), and facilitate smooth execution of work** (KIIs).

Better integration and common thinking have been encouraged over the years. For example, the Excellence in Breeding (EIB) platform has facilitated work in a much more unified way, thus helping management and governance of the CRP. CRP funding is distributed in collegial way, offering scope for more efficiency and change. However, uncertainty associated with the annual allocation of budgets to different flagships, centers, and partners has allowed some drift to happen.

The strength of the RICE CRP lay in its collaboration with CGIAR and non-CGIAR centers as core partners. CIAT, CIRAD, JIRCAS, and IRD have brought in their advantage and experience in Africa and created shared resources across the centers. Even though 95.5% of CRP funding was held by IRRI (76%) and Africa Rice (19.5%), the other four centers contributed expertise and resources to provide unique dynamism to the design and delivery of the CRP research. CIAT brought in its experience with Fondo Latinoamericano para Arroz de Riego (FLAR, a successful public-private partnership in Latin America) and advanced rice genetics to contribute to RICE work, especially in West Africa. JIRCAS shared its expertise and resources with FP3, which has delivered a large portfolio of work. JIRCAS, CIRAD, and AfricaRice have collaborated well in Africa, working closely together for farming systems research and soil fertility improvement in Madagascar. Non-CGIAR centers, though, are not clear how the relationships will work out in One CGIAR. Because MARLO was designed for CGIAR Centers, it was difficult for CIRAD, IRD, and JIRCAS to adopt it, and so it is felt that MARLO does not fully capture the contributions of non-CGIAR centers (KII).

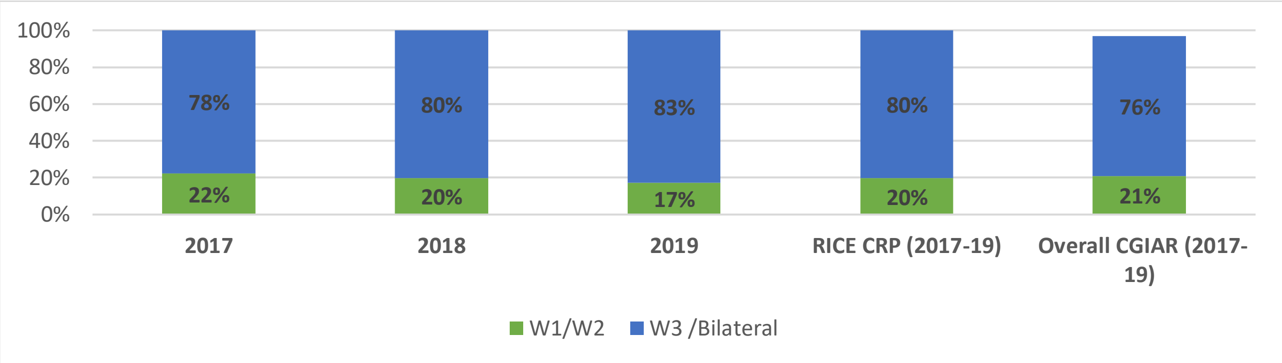
AfricaRice's standing with member governments in Africa has served the CRP well in policy influence. AfricaRice has a close association with governments in Africa, where 28 countries are part of its membership network. These links have and can continue to facilitate better adoption of CRP innovations and products. According to one key informant, AfricaRice would need more and longer-term funding to do impactful policy engagement on several RICE innovations and products.

PPMT and ISC mechanisms were found to be useful by most scientists. These mechanisms were important strategic touch points where the CRP leadership and management teams could discuss strategic and operational issues, generating and recommending ideas to improve CRP work. The **ISC was particularly appreciated** for providing regular recommendations to FP leaders. PPMT meetings were less useful to the FP leaders as they were designed to provide operational updates to the management team. In a PPMT meeting in 2018, the CRP planned an enhanced role for PPMT because a CRP leader was taking a part-time role. In further PPMT meetings and conversations with PPMT members, it was not clear whether PPMT members took on this enhanced role (KIIs, PPMT and ISC meeting minutes).

Center focal point arrangements within RICE have worked well, though staff turnover has created coordination missteps. Every FP has institutional focal points. This structure of shared leadership allows one person to lead and involve others from other Centers. However, with staff turnover, especially at IRRI, this arrangement created coordination problems for FPs led by other Centers, such as FP3, led by AfricaRice.

RICE realized that cross-CGIAR partnerships with A4NH, CCAFS, and PIM are much needed in several areas of collaborative research on nutrition, climate change, and policy uptake, respectively. While partnerships (across CGIAR Centers) worked in some instances, **they did not make RICE as integral part of these CRPs. Several RICE scientists consider this a missed opportunity.** There was willingness to collaborate, but funds available to operationalize that willingness were severely limited. FP2, FP4, and FP5 could have contributed to A4NH work in several areas, but apart from meetings there was no substantive engagement (KII). In recent years, IRRI collaborations with WorldFish and IWMI have been strengthened.

Figure 8: Sources of RICE CRP funds, 2017–19



Bilateral sources of funding constituted 52% (80% if W3 is included) for the RICE CRP from 2017 to 2019 (Figure 8). For CGIAR, bilateral sources of funds are significant, at 44% of all funds. With bilateral and W3 constituting more than three-fourths of RICE funding, it is important to have accountability mechanisms for this source of funds to the CRP. RICE has more than 100 bilateral projects mapped to the program. Generally bilateral projects are multimillion dollar projects funded by the Bill and Melinda Gates Foundation (BMGF), the US Agency for International Development (USAID), and other donors.

The reviewers could get access to only a few reports of project evaluations. This indicate that only a **few bilateral projects have received project evaluations, either commissioned by bilateral donors or by the CGIAR Centers**. The project evaluations of some bilateral projects where reviews or evaluations were done (and whose reports were shared with the review team) were not methodologically robust. Project evaluations essentially are evaluations of constituent components of the CRP and therefore can be useful in CRP level reviews or evaluations (KIIs, CGIAR Dashboard, project evaluation reports).

CRP scientists found MARLO complex to use. Its data structure and definitions were not clear to the CRP team. The CRP team believes that MARLO provides an incomplete picture of CRP progress, whereas RICE annual reports provide a near-complete picture of CRP progress (KIIs).

2.2.4 Progress along ToC (CRP and Flagships)

The RICE ToC is logically structured at four levels of impact pathway: discovery research, product, adoption, and outcome. In ToC parlance, "discovery research" corresponds to research activities; "product" corresponds to immediate research outputs; "adoption" corresponds to research uptake; and "outcome" corresponds to development outcome and subsequently impact.

This presentation of the CRP and FP theories of change is logically consistent and plausible (reviewers' assessment of the ToC, KIIs). In the ToC, risks are identified across the pathway for results transitions to happen. At the same time, enabling actions are developed to minimize the risks that CRP may encounter during ToC progression. There are minor inconsistencies in the FP-level ToCs—e.g., "increased productivity" is correctly listed as an outcome in the FP1 ToC, but incorrectly listed as an impact in the ToCs of other FPs. Another inconsistency is that "enhanced small-holder market access" is listed as an impact in the FP3 theory of change, but it can be considered either an outcome or a strategy/enabling action to achieve outcome or impact. These inconsistencies are highlighted in Annex 10. The RICE CRP has invested an average annual budget of US$67 million to serve two types of beneficiaries:

- **Intermediate or next users:** RICE has more than 900 contractual and non-contractual partners that are intermediate users. RICE continues to work with a range of partnerships—NARSs (such as nodal research institutions in India, the Philippines, and Bangladesh, FOFIFA in Madagascar); academic and research organizations; private companies (such as GrainPro, ACI seeds, Sarmap); regional organizations (such as ECOWAS, CARD); global platforms (such as Sustainable Rice Platform, Direct Seeded Rice consortium); and advanced research institutes (such as NIAS-Japan, University of Adelaide–Australia).
- **End users** of RICE CRP products are millions of rice value chain actors such as farmers, millers, processors, traders, and consumers.

RICE has achieved significant progress on the CRP- and FP-level ToCs, though more would need to be done in terms of scaling up RICE innovations. Several instances of reported progress on RICE innovations can be construed as significant impact of the RICE CRP on sub-IDOs/IDOs. However, it is clear that these reported impacts are at demonstration sites or for smaller numbers of farmers who participated in the trials, though in some instances robust evidence of scaling up is available, especially related to the adoption and impact of some varieties. In a majority of innovations, the extent of the scaling up of adoption and impact is not yet evident. It is well acknowledged by stakeholders that RICE innovations are international public goods and hold monumental potential. However, there is currently no transparent and accessible database of all its innovations in terms of level of adoption and impact by countries or by states or provinces within countries (KIIs, Dashboard data, CAS analysis, annual reports, websites of RICE projects and platforms such as CARD and Closing Rice Yield Gaps [CORIGAP]).

The RICE CRP has not used the ToC for program reflection and reporting. Parts of the ToC are used, as required by the CGIAR System, for reporting using MARLO and annual reporting on milestones, innovations (by levels), and policy influence (by stages). The culture of impact thinking in the CRP has improved over the years, as confirmed by several FP and CoA leaders. CGIAR System–mandated templates have contributed to greater use of theories of change in planning, reviewing, and reporting on outcomes, innovations, and policy uptake. However, ToC as a tool has been less used; several scientists admitted not having seen the ToC again after it was devised in 2016 (KIIs, annual reports). Additional analysis on flagship-level theories of change is presented in Annex 10.

In most cases (except for some SPIA–commissioned evaluations), the impact evaluations of RICE work on different aspects (such as material, management technologies, tools, policy influence) is led by FP1, with participation or advice from external stakeholders. It is evident that this team's capability to conduct robust assessments has improved over the years. However, **this peer review and evaluation system presents potential for a conflict of interest**. Since critical impact dimensions were being assessed, external team participation in the lead roles in some cases could have provided more credibility and confidence in the quality of evidence so generated (KIIs, OICRs).

Table 4 Progress on the CRP theory of change

TOC element	ToC description in the 2016 RICE proposal	**Reviewer's Reflection** *(assessment based on data from several sources – ARs, pub., OICRs, dashboards, MARLO/CAS analysis, key informant interviews)*
Discovery research/ activities	Upstream research results in discoveries and innovations that are translated into concrete products that are introduced, evaluated, improved, and disseminated to intermediate users, and finally become adopted by end users, impacting millions of beneficiaries. Partners play a key role in all stages of the pipeline, and there are many feedback loops among researchers, development partners, and users.	RICE annual reports and CAS pre-analyzed data list 224 innovations/concrete products that has developed over phase 1 (GRiSP) and phase 2 of the CRP. Several of these are new innovations developed over 2017–19. RICE has established extensive partnerships with research, delivery, and policy institutions. RICE research innovations are in different stages: 52% of innovations are in stage 1 or 2; 48% of innovations are in stage 3 or 4 (ready for uptake or uptake by next users). This demonstrates stellar performance in discovery and delivery of science in the rice agri-food system by the CRP. RICE has built on its GRiSP legacy and continued to deliver credible science.
Product/ research outputs	Discovery research leading to prototype of improved product; men and women farmers and other value chain actors at pilot sites validate, adapt, and adopt improved products.	RICE has proven effective in developing a pipeline of new products during 2017–19. The challenge for RICE is to take these innovations on the scaling pathways.
Adoption/ immediate outcome or research uptake	Large-scale dissemination: Large numbers of men and women farmers and value chain actors adopt.	RICE faces a challenging prospect when disseminating its innovations on a large scale while meeting the demands of its quality of science. While half of RICE innovations have reached stage 3 or 4, it is difficult to say that these innovations have been adopted at a wide scale, benefiting millions of farmers and value chain actors. Only a handful of RICE varieties (such as NERICA, WITA9, *sub1*) and management practices (satellite-based rice monitoring, smart valleys) would be eligible for that distinction.
Outcome	Increased productivity; increased profitability for men and women farmers and other value chain actors; availability of nutritious and high-quality rice at low price to poor men and women consumers.	RICE adoption and impact analysis have largely established that if the RICE products are consistently adopted, the benefits in terms of productivity (generally estimated as a 0.5 to 3 t per ha increase) and profitability (additional income of US$100–300 per ha) are significant. The challenge, as stated earlier, is in upscaling of RICE innovations, including mainstreaming within government policies and successful commercialization by the private sector.
Impact	Decreased poverty; increased food and nutrition security; health and sustainability; enhanced gender equity.	In the current phase of the CRP, based on several impact studies reported in the 2017–19 annual reports, it is estimated that RICE might have impacted about 2 million farmers with decreased poverty and increased food and nutrition security.

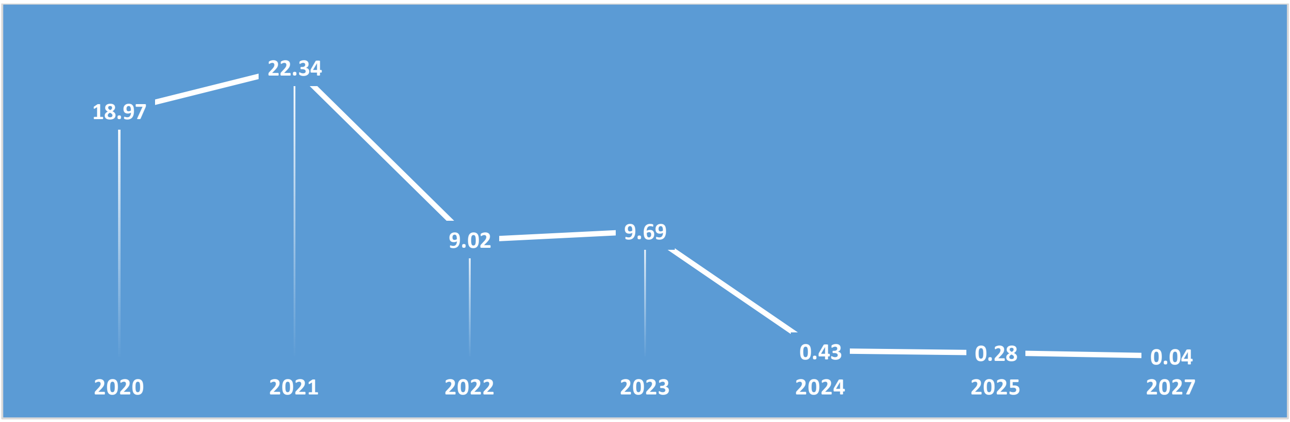
TOC element	ToC description in the 2016 RICE proposal	**Reviewer's Reflection** *(assessment based on data from several sources – ARs, pub., OICRs, dashboards, MARLO/CAS analysis, key informant interviews)*
Enabling actions or strategies to achieve the stated results	In 2016 RICE proposed a set of six actionable and interconnected elements of its enabling environment: 1. Monitoring, evaluation, and learning (ME&L). To foster an impact pathway culture, a strong ethos of collective monitoring and evaluation of progress and of using learning data for continuous improvement is required. 2. Communication. Good communication along the whole impact pathway is critical for RICE to deliver its development impacts.	The RICE CRP has not used ToC for program reflection and reporting though parts of the ToC are addressed through MARLO reporting on milestones, innovations (by levels), and policy influence (by stages). In this CGIAR-mandated way of reporting, critical annual reflection and analysis of the following is lacking to the desired level of efficacy: - How did ToC result transitions transpire during the past year; especially, what worked and what did not work, with some examples? - How did RICE perform on the envisaged risks and assumptions during the past year? What new risks and assumption were witnessed? - What enabling actions were taken by the CRP to address the risks experienced, and to what extent these were effective? What new enabling actions would be needed to improve progress on the theory of change?
Enabling actions or strategies to achieve the stated results	In 2016, RICE proposed a set of six actionable and interconnected elements of its enabling environment: 3. Gender awareness. Culture is an important dimension of enabling environments. An important aspect of culture in the agricultural R&D arena is that of gender (in)equalities—and the perceptions of these—within and among all actors along the impact pathway. 4. Capacity development. RICE adopts the CGIAR capacity development framework as a comprehensive structure to systematically strengthen capacity among partners and actors along its impact pathway.	NARSs are key RICE partners, each with different capacity development needs. While several capacity developments actions have taken place, it is not evident whether these were based on a holistic understanding of capacity barriers that exist for different NARSs for achieving success in specific initiatives. For example, as a technical collaboration, NARSs in Africa expect a hands-on capacity development approach from RICE, while NARSs in Bangladesh and India expect a continued relationship with RICE to facilitate increased government investments in building infrastructure and national capacities.
Enabling actions or strategies to achieve the stated results	In 2016, RICE proposed a set of six actionable and interconnected elements of its enabling environment: 5. Partnership building. RICE actively engages with partners along its whole impact pathway, from upstream research to downstream scaling up. The private sector is increasingly recognized as a key player in bringing new technologies to markets and end users and features prominently in RICE's partnership strategy.	RICE has continued to strengthen its private sector engagement in Africa, learning from approaches that have worked in Asia. RICE has started bringing in its Asian experience to use in Africa by deploying private sector experts from Asia to work with national experts in specific African contexts. This process would need to be accelerated.

TOC element	ToC description in the 2016 RICE proposal	**Reviewer's Reflection** *(assessment based on data from several sources – ARs, pub., OICRs, dashboards, MARLO/CAS analysis, key informant interviews)*
Enabling actions or strategies to achieve the stated results	In 2016, RICE proposed a set of six actionable and interconnected elements of its enabling environment: 6. Policy support. Like culture, policy is an important dimension of enabling environments in the development arena. The PIM CRP is the main avenue for developing and disseminating policy support to facilitate scaling up and uptake of new technologies, products, and services.	The RICE CRP has influenced policies in 25 instances. However, in only one instance (Vietnam policy supports for "1M5R" practice) has it achieved level 3 (evidence of impact on people and/or the natural environment of the changed policy or investment). Level 2 (policy/law, etc., enacted) has been achieved in 7 instances, and level 1 (research taken up by next user such as decision-maker or intermediary) has been achieved so far in 17 instances. This is good progress in improving the enabling environment for rice agri-food systems. This progress is more pronounced in Southeast Asia and West Africa, perhaps because IRRI and AfricaRice are situated in these regions. However, more strides would need to be made in main rice-growing areas of Sub-Saharan Africa and South Asia.
Risks and assumptions, during result transitions in the theory of change	Successful scaling up depends on the (inter)actions and policies of all actors involved—from research to development—in developing and bringing to scale novel products and services that contribute to the realization of development outcomes. Risks include: value chain actors do not process the product (outcome to impact); men and women consumers do not appreciate the product (outcome to impact); price of rice is too high for consumers (outcome to impact); production of rice is not profitable for consumers (outcome to impact); product does not respond to the needs of men and women farmers and other value chain actors or consumers on a large scale (immediate outcome to outcome); markets do not absorb the product (immediate outcome to outcome); benefits do not accrue to men and women adopters along the value chain (immediate outcome to outcome); scaling and delivery partners are not effective (output to immediate outcome); product is not acceptable to men and women farmers and value chain actors (input to output); discovery research does not lead to improved product (input to output).	Most of the listed assumptions, fortunately, stayed valid for RICE to effectively implement the program without experiencing serious roadblocks. The RICE team should be credited for undertaking enabling actions to ensure that risks and assumptions do not undo its research work. However, several new assumptions (or risks) not envisaged in 2016 played out, some of which are listed below: • Affordability of rice products (e.g., Super Bag, bubble dryer) restricts uptake. • Mainstreaming of rice products in policies and regulations is not widely seen. • Context suitability of rice innovations is not proper in some contexts, such as submergence tolerance varieties in Bangladesh. • Scaling pathways do not work due to agronomy, seed system, and other operational challenges. • The private sector is not interested in promoting rice varieties, e.g., in unfavorable environments in Sub-Saharan Africa. • Strength of the public system in delivering RICE innovations is limited, e.g., in several countries of Sub-Saharan Africa. • Funding and infrastructure–related challenges are faced by NARSs. e.g., in Bangladesh. • Financial access on the part of farmers, agri-entrepreneur youth, and women constrain their ability to adopt business models, as seen in several instances. • Cultural and structural norms act as barriers to women's participation in the rice value chain, as seen in several instances. • RICE prioritization due to uncertain funding leads to weaning away too early from some promising innovations, as may have happened with an estimated one-third of innovations. • Center-level reorganization destabilizes operations across the RICE CRP, as happened during 2017/18. • High staff turnover and other human resources issues lead to dilution of work, as happened in several flagships. Most of the staff listed in 2016 proposal left the CRP, and RICE faced challenges in retooling and retraining. The RICE CRP would need to update its ToC based on experience from 2017 to 2019. It is evident that a set of new enabling actions would need to be designed to tackle new risks (and assumptions) as experienced by the program.

2.3 Future Orientation

RICE, with IRRI and AfricaRice, is well situated to progress strongly into the future in terms of its **future funding pipeline and its reputation for credibility with key national and international partners, including donors.** In several countries (such as the Philippines, India, Vietnam, Myanmar), RICE has made inroads into policy circles, developing relationships with the relevant government ministries and departments. In fact, governments in these countries have started funding IRRI to provide support for upscaling. Given bilateral donor support as well, the future pipeline of work in these countries is expected to be strong (see Figure 7).

Figure 9: Assured future funding estimates, within and beyond CRP phase II (million US$)



Note: Based on data from the CGIAR financial dashboard; estimates are based on existing contracts from bilateral donors and other sources, and the average annual budget is calculated based on total budgets and duration of the project. This does not include W1/W2 and W3 funds.

Movements on other fronts also paint a picture of strength for RICE to go forward strongly in the future. **Demand for RICE innovations, climate change, nutrition science, engagement, and outcomes will only grow**. A key aspect of RICE's success is the collaboration across countries and partners. These relationships will be crucial for future success. Some promising examples are the following:

- IRRI, WorldFish, and IWMI recently signed a five-year agreement for research for development cooperation in enhancing rice-fish production systems in South and Southeast Asia. This new partnership, which builds on previous successful collaborations by the three institutes, is aligned with CGIAR plans to usher in a food systems revolution by 2030 and serves as a model for greater cooperation between Centers in tackling multifaceted global challenges.
- As per an audited financial report of IRRI (2018), a major accomplishment in 2018 in the area of infrastructure was securing perpetual financial support from the Global Crop Diversity Trust for the maintenance and operation of the International Rice Genebank. The grant, amounting to a generous US$1.4 million annually in perpetuity, is a significant achievement for IRRI, attesting to the high standards and quality of IRRI genebank operations.
- One of the RICE's innovations, 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.
- Starting in 2017 RICE work on nutrition assumed greater focus and intensity, with the BMGF providing US$18 million in funding for healthier, nutritionally enhanced rice. Mainstreaming high-zinc content in irrigated breeding targets was initiated. RICE partner CIAT has an advanced research program on nutrition, working with A4NH, AfricaRice, and CIRAD through the A4NH CRP.

A major risk RICE will face in the future is shifting donor priorities, away from cereal crops to larger integrated development research and innovations to address grand challenges facing humanity (climate change, nutrition, Covid-19 and other pandemics, pandemic-induced poverty and hunger, and sustainable intensification). While the CGIAR System is attuned to addressing these shifts, donors themselves have shown their inclination to move away from W1/W2 commitments to more bilateral commitments (see Figure 8). RICE will have to strike a balance between discovery and delivery of science; it can continue to issue hundreds of new products every year that do not go far on the scaling pathways, or it can choose real-world application of its science. Scaling up RICE's existing innovations has a high potential to address the grand challenges but doing so would require a considerable shift in the RICE team's orientation and strategies to demonstrate feasibility and moving fast to stay in the game. RICE's continued work on a large scale in mega-deltas and in unfavorable environments, on climate change, and on nutrition, with the integration of gender and youth, is likely to define its future.

2.4 Cross-Cutting Issues

2.4.1 Capacity Development

The RICE CRP has demonstrated its emphasis on capacity development (CapDev) and partnerships across all FPs and at four levels (discovery, product, adoption, and outcome) of results of its TOC. In close to 60% of research outputs delivered by RICE, capacity development is an important consideration, as either a principal or a significant component of the output delivered by the CRP.

RICE has carried out short-term trainings for next users (in innovation platforms and policy workshops) and end users (in farm trials and farmer field days). As per Dashboard data, RICE has covered 183,163 participants, of whom 40% were female, in short-term trainings. It has provided long-term training through its Scholars program, covering bachelor, master's and PhD courses. From 2017 to 2019, a total of 1,566 scholars have been covered by these trainings, with 51% female participation.

On an average during 2017-2019 RICE worked with more than 375 discovery and delivery partners. Given the diversity of partnerships, capacity development requirements and approaches are likely to be different. One of the enabling actions proposed in the RICE ToC is that "RICE would adopt the CGIAR CapDev framework as a comprehensive structure to systematically strengthen capacity among partners and actors along its impact pathway." However, the critical thinking and actions on the CGIAR CapDev framework for different countries are not reflected in annual reports or other CRP documents. NARSs and NARESs are key RICE partners, each with different capacity development needs. While several CapDev actions have taken place, **it is not evident whether these were based on a holistic understanding of capacity barriers that exist for different NARSs or NARESs for achieving success in specific initiatives**. For example, as a technical collaboration, NARSs in Africa expect a hands-on capacity development approach from the RICE CRP while NARSs in Bangladesh and India expects a continued relationship with RICE to facilitate increased government or donor investments in building infrastructure and national capacities.

In the current phase of the CRP, RICE recognizes that many countries do not have the public systems to disseminate new varieties and so **working with the private sector is a necessity to disseminate new varieties**. The CRP has learned the way to engage with the private sector in terms of offering intellectual property rights or other incentives. This is one enabler of CRP success in countries such as India, Bangladesh, the Philippines, and Vietnam. Private sector engagement and capacity building would need to be further enhanced, especially in Africa, in the remainder of the timeframe of the CRP.

RICE has used public-private partnerships in several instances, such as FLAR, the DSR consortium, irrigated rice global platform, and CARD. More evidence would be needed to understand the effectiveness and utility of these public-private partnership platforms.

Overall, evidence indicates that **RICE should contextualize its capacity development framework to respond to the diverse requirements of NARSs in Africa versus Asia**. RICE can be a facilitator with some NARSs in Asia as they are more likely to have the capacity needed to do their own R&D. The CRP can broker and manage knowledge rather than researching or implementing in some NARSs in Asia and Africa. RICE can continue to lead on research and innovations with some other NARSs in Africa. A country's NARS better understands the context and their government's needs; collaboration with NARSs should start from the beginning of a research project. One of the strategies that has worked (for example, in Benin) is to identify the champions within NARSs and work with them intensively. More detailed analysis of capacity development and partnerships is presented in Annex 13.

2.4.2 Climate Change

Evidence from 2017 to 2019 strongly indicates that RICE has integrated climate change research into its programming, as a standout example of systems research, while still focusing on a commodity with CCAFS. The RICE and CCAFS CRPs have worked on a range of climate change research areas such as the scaling of new climate-smart technologies, stress-tolerant varieties, protocols on water-saving technologies, climate-smart villages in the Mekong River basin, bridging of the gap between science and policy, mitigation of methane emissions in Vietnam and Bangladesh, and the co-benefits of AWD. Hundreds of QTLs/genes, models, products, and technologies developed by RICE have good potential for achieving climate adaptation and resilience and contributing to climate change mitigation as well. RICE technologies are already being adopted, though most adoptions so far are site specific and not at wide scale. These adoptions have clearly demonstrated the potential of RICE technologies to improve resilience and reduce greenhouse gas emissions. **Besides the China example,[7] there is so far limited evidence that RICE's climate change research has contributed to large-scale reductions in greenhouse gas emissions**. Potential of RICE innovations contributing to climate mitigation and resilience is well studied and established. Small-scale adoptions have contributed to small-scale outcomes, and further dissemination and adoptions are likely to increase the quantum of impact. A detailed ToC-based analysis of climate change is presented in Annex 14.

2.4.3 Gender

The RICE CRP has demonstrated its gender inclusiveness across all FPs and at four levels of results of its theory of change (discovery, product, adoption, and outcome). Evidence of results across multiple data sources[8] shows commendable achievements on gender mainstreaming in RICE CRP. Close to 60% of research outputs delivered by RICE give an important consideration to gender, as either a principal or a significant component of the output delivered by the CRP.

Analysis of gender integration across RICE ToC indicates a funnel-like approach: work starts with a large number of activities in discovery research, leading to some being piloted and a few being taken forward to adoption, resulting in a few gender outcomes. Discovery research is rightly pitched at identifying business models, diversification, and value chain opportunities that would work for women. Only a limited set of activities that were found to improve women's participation in the RICE value chain were taken forward to piloting and capacity development. Limited resource availability (and associated financial uncertainties) at FP2 and FP3 might have contributed to lower expectations around what could be accomplished. Seed production and GEM (Grain quality-enhancer, Energy efficient and durable Material) parboiling appear to be the most promising business models for women, according to evidence on adoption. Notably, other promising avenues (such as prototype labor-saving technologies and post-harvest technologies) were not adopted at scale; work to achieve greater adoption would need to be done by RICE in the remainder of the CRP timeframe. Strong gender outcome evidence is available on agriculture mechanization in one country and on GEM parboiling in another country; these are clearly significant gender outcomes achieved by RICE during 2017–19. As demonstrated in the detailed gender analysis (see Annex 11), **RICE has ample technologies and business models where gender outcomes can be improved and where specific technologies can be made contextually relevant.** More detailed analysis on gender integration in research is presented in Annex 11.

2.4.4 Youth

Youth-related programming in RICE is still nascent. Lack of resources is cited as one of the reasons by the RICE team. RICE has allocated resources to youth programming only in the past year, and consequently a youth strategy has been developed in 2019. This strategy is likely to guide future actions and funding mobilization for achieving an appropriate level of programming.

Youth is an important consideration as either a principal or a significant component in less than 50% of research outputs delivered by RICE. RICE has made marginal efforts on youth-related activities and results along the theory of change. It is not evident whether any adoption- or outcome-level result is being achieved by RICE on youth. Evidence on all these results has been harvested from multiple data sources to indicate that the RICE achievements on youth programming are marginal. RICE identified several ways in which youth can be better targeted and benefited in the value chain—a necessary step, but more could have been done. Digital agriculture (RiceAdvice, Rice Crop Manager, RiceDoctor) presents a potential opportunity for youth to become agri-entrepreneurs by providing services to fellow farmers.

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[7] In collaboration with the Chinese government, RICE developed a mix of over 500 rice varieties and hybrids that perform well with fewer inputs and provide multiple tolerances from biotic and abiotic stresses. The project introduced inbred and hybrid Green Super Rice (GSR) varieties in 11+ countries in Asia and Africa, with more than a million hectares devoted to these climate-smart cultivars (FP3, FP5).

[8] Annual reports, CAS pre-analyzed datasets, OICR case studies, Key Informant Interviews with RICE partners and stakeholders

RICE can explore such opportunities in upscaling its innovations. The challenge RICE faced was how youth can be appropriately engaged in specific business models and entrepreneurship activities given the lack of necessary finance, equipment, and business development support. RICE would need to address these constraints through appropriate partnerships. RICE can also learn from the agribusiness incubator program run by ICRISAT and the Grain Legumes and Dryland Cereals CRP (GLDC). Youth-level outcomes and impacts are not evident from RICE so far. More detailed analysis on youth is presented in Annex 12.

3 Conclusions and Recommendations

3.1 Quality of Science

3.1.1 Quality of Research Inputs

RICE has access to high-quality and appropriate human resources and delivers credible and legitimate research. Efforts are needed to create gender balance in management and decision-making positions.

3.1.2 Quality of Process (including Partnerships)

RICE management processes support relevance, credibility, and legitimacy, but gender integration can be strengthened.

3.1.3 Quality of Outputs

Outputs are impressive in terms of relevance, credibility, and legitimacy. Large variability in terms of delivery of outputs and of acquisition of bilateral funding was evident among FPs and partners. While IRRI and AfricaRice are the two main partners in the CRP (with 95.5% funding allocation), it is less clear why the other four Centers have allocations and corresponding scientific outputs that are so much lower.

3.2 Effectiveness

3.2.1 Achievement of Planned Outputs and Outcomes

The rate of milestone completion (79%) by the third year of the five-year project demonstrates effective planning and execution in the CRP. All flagships except FP4 have achieved most of their milestones in time. Insufficient finances and staff turnover are highlighted as reasons for non-completion or delay in achieving milestones. Facing budgetary uncertainty, RICE compromised upscaling activities in FP2 and FP3, potentially limiting the CRP's achievements. Despite budget cuts and uncertainties, the RICE CRP has demonstrated a stellar performance in discovery and delivery of science in rice agri-food systems. However, adoption levels for several RICE innovations are still weak. Seed system work would require greater attention than what has been possible within existing flagship and CoA arrangements and funding allocations.

3.2.2 Demonstrated Importance of Outcomes

RICE adoption and impact analysis has largely established that if RICE products are consistently adopted, the benefits in terms of productivity (generally estimated as a 0.5–3 t per ha increase) and profitability (additional income of US$100–300 per ha) are quite significant. The challenge, as stated earlier, is in upscaling RICE innovations, including mainstreaming them within government policies and successful commercialization by private sector.

Many of the technologies and innovations contained in OICRs are in the pilot or scaling phases. An in-depth analysis of evidence presented across OICRs indicates that several RICE technologies would continue to need better strategies and more investments to increase the level of adoption and impact being achieved. RICE recognizes that many countries do not have the public systems needed to disseminate new varieties, and so working with the private sector is a necessity. CRP has learned how to engage with the private sector in countries such as India, Bangladesh, the Philippines, and Vietnam. While several capacity developments actions for NARSs have taken place, it is not evident whether these were based on a holistic understanding of capacity barriers that exist for different NARSs in achieving success in scaling.

Several barriers to adoption and impact have been experienced. For example, affordability is a big issue that rice farmers have faced regarding adoption of several RICE innovations such as the hermetic Super Bag, the bubble dryer, or AWD. These barriers would need to be overcome for RICE to improve its impact.

3.2.3 CRP Management and Governance

All-around appreciation for the quality of CRP leadership was voiced: several scientists acknowledged RICE leadership and continuity at the helm to be the main drivers of the CRP's success. The quality of fostering by the lead Centre (IRRI) was appreciated too. However, there is a perception that IRRI could have done more in terms of enabling and recognizing good work, fostering efficient internal structures (rather than duplications), and facilitating smooth execution of work.

The PPMT and ISC were found to be useful by most scientists. These were important tactical touch points for the CRP leadership and management teams to discuss strategic and operational issues, generating and recommending ideas for improvement of CRP work. The role of the ISC was particularly appreciated for providing regular recommendations to flagship leaders.

RICE realized that cross-CGIAR partnerships with A4NH, CCAFS, and PIM are much needed in several areas of collaborative research on nutrition, climate change, and policy uptake, respectively. While partnerships (across CGIAR Centers) worked in some instances, they did not make RICE an integral part of these CRPs and vice versa. Several RICE scientists consider this a missed opportunity.

With bilateral sources and W3 constituting more than three-fourth of RICE funding, it is important to have accountability mechanisms for this source of funds to the CRP. RICE has more than 100 bilateral projects mapped to the program. Few bilateral projects have received project evaluations, commissioned either by bilateral donors or by the CGIAR Centers.

MARLO was found to be a complex system CRP scientist to use. Its data structure and definitions were not clear to the CRP team.

3.2.4 Progress along ToCs (CRP and Flagships)

The RICE ToC is logically structured at four levels of impact pathway: discovery research, product, adoption, and outcome. This presentation of the CRP- and flagship-level theories of change is logically consistent and plausible. There are minor inconsistencies in the flagship level theories of change, which have been highlighted by this review.

RICE has achieved significant progress on the CRP- and flagship-level ToCs, though more would need to be done in terms of scaling up RICE innovations. Several instances of reported progress on RICE innovations can be construed as significant impacts of RICE CRP on sub-IDOs/IDOs. However, it is clear that these reported impacts are at demonstration sites or for smaller number of farmers who participated in the trials.

The RICE CRP has not used the ToC as a template for program reflection and reporting, though parts of the ToC are used, as required by the CGIAR System, for reporting, using MARLO and annual reporting on milestones, innovations (by levels), and policy influence (by stages). The culture of impact thinking in the CRP has improved considerably over the years, as confirmed by several flagship and CoA leaders.

Most of the assumptions listed in the ToC, fortunately, stayed valid for RICE so it could effectively implement the program without experiencing serious roadblocks. The RICE team should be credited for undertaking enabling actions to ensure that risks and assumptions did not undo its research. However, several new assumptions (or risks) not envisaged in 2016 played out, including the following:

- The unaffordability of rice products (e.g., Super Bag, bubble dryer) restricts uptake.
- Scaling pathways may not work owing to agronomy, seed system, and other operational challenges.
- The private sector is not interested in promoting rice varieties in, e.g., unfavorable environments in Sub-Saharan Africa.
- The strength of the public system in delivering RICE innovations is limited in, e.g., several countries of Sub-Saharan Africa.
- NARSs in Bangladesh and elsewhere face funding and infrastructure-related challenges.
- Lack of access to financing constrains the ability of farmers, agri-entrepreneur youths, and women to adopt business models, as seen in several instances.

- Cultural and structural norms act as barriers to women's participation in the rice value chain, as seen in several instances,
- High staff turnover and other human resources issues led to dilution of work, as happened in several flagships. Most of the staff listed in the 2016 proposal have left the CRP, and RICE has faced challenges in retooling and retraining.

The RICE CRP would need to update its ToC based on its experience from 2017 to 2019. It is evident that a set of new enabling actions would need to be designed to tackle new risks (and assumptions) as experienced by the program.

In most cases (except for some SPIA-commissioned evaluations), the impact evaluations of RICE work on different aspects (such as material, management technologies, tools, policy influence) are led by FP1, with participation or advice from external stakeholders. It is evident that the capability of this team to conduct robust assessments has improved over the years. However, this peer review and evaluation system presents the potential for a conflict of interest.

3.3 Future Orientation

RICE, with IRRI, AfricaRice, and other Centers, is well situated to progress strongly into the future in terms of its future funding pipeline and its reputation for credibility with key national and international partners, including donors. In several countries (such as the Philippines, India, Vietnam, and Myanmar), RICE has made inroads into policy circles, and relationships have been well developed with the relevant government ministries and departments. In fact, the governments in these countries have started funding IRRI to provide support for upscaling. Given bilateral donor support as well, the future pipeline of work in these countries is expected to be strong.

The outlook is not without risks and challenges. A major risk RICE will face in the future is shifting donor priorities away from cereal crops to larger integrated development research and innovations to address the grand challenges facing humanity (climate change, malnutrition, Covid-19 and other pandemics, pandemic-induced poverty and hunger, and sustainable intensification). While the CGIAR System is attuned to addressing these shifts, donors themselves have shown an inclination to move away from W1/W2 commitments toward more W3/bilateral commitments.

3.4 Cross-Cutting Issues

Capacity development: The RICE CRP has demonstrated its emphasis on capacity development and partnerships across all flagships and at four levels (discovery, product, adoption, and outcome) of results of its ToC. RICE's capacity development framework would need to be made more context specific to address differing requirements across Africa and Asia.

Climate change: RICE has integrated climate change research into its programming. In that respect, RICE is a standout example of systems research, while still focusing on a commodity. RICE technologies have good potential for achieving climate adaptation and resilience and contribute to climate change mitigation as well.

Gender: The RICE CRP has demonstrated its gender inclusiveness across all FPs and at four levels of results of its TOC (discovery, product, adoption, and outcome).

Youth: Youth programming is nascent in the CRP. More investment and focus are needed.

3.5 RICE CRP-Level Recommendations

1. **RICE should continue to strengthen its work on seed systems** with a dedicated team and partnership network. Investments in this area should be at least doubled. RICE has already started using outside private sector expertise in Africa and Asia, and more of this would need to be done.
2. **RICE should explore greater interactions and cooperation among its participating Centers so that each has significant prestige and a stake associated with involvement in the program**. To the extent feasible within the remainder of the CRP timeframe, all Centers (including non-CGIAR centers) should mobilize funds and capacities to the CRP and close the gaps between differences in research outputs (publications) and bilateral funding delivered by Centers as part of the CRP.

3. **Scaling of CRP innovations would require efficiencies in the value chain,** and therefore RICE's impact would be enhanced by a greater focus on value chains; this was noted by the evaluation of GRiSP as well. At the same time, agronomy at scale would be needed, and an economic model would need to be developed for postharvest technology to become affordable to farmers. RICE should critic ally examine the status of its innovations, especially those that have completed successful pilots and determine whether scaling pathways for the most promising innovations have been worked out. RICE needs to find ways to link better with other CRPs. For example, its research on grain nutrition (Zn, starch characteristics) is high quality, and linking it with A4NH and wider food systems will benefit RICE as well as the other CGIAR priorities. Also, scaling pathways should give due emphasis to the remunerative integration of women and youth in the rice value chains.
4. **To the extent feasible in 2021, RICE programming can better frame its sustainable intensification work** using intensification toolkits[9] at specific sites. Currently a range of activities at different sites may not provide a whole system view of what is happening and what is needed to achieve sustainable intensification. To this end, the work done by Feed the Future Lab on innovation in sustainable intensification can be adapted to RICE environments. RICE should increase its research on sustainable production trade-offs. RICE should endeavor to determine the true cost of producing rice, how to manage trade-offs in sustainably producing rice, how to respond effectively to a changing climate, and how to manage biodiversity conservation. IRRI has a comparative advantage in genetic improvement but can build up strength in sustainable intensification as well, working with other CGIAR Centers, the USAID's Feed the Future Innovation Lab, and other complementary partners.
5. **An in-depth and independent review of private sector engagement with RICE for upscaling and adoption can be carried out to guide engagement models** for achieving wider adoption and deeper impact. It will also be pertinent to review the effectiveness and impact of existing public-private partnerships (such as CARD, DSR consortium, FLAR) as these can guide future strategies of engagement, which are likely to be helpful for upscaling. Working collaboratively with other centers, IRRI/RICE can strengthen its engagement with the Association of South East Asian Nations (ASEAN) and other regional frameworks and platforms in Asia to replicate its Africa experience on policy engagement.
6. **Project-specific ToCs could be more granular and useful in helping individual scientists to track progress**. TOCs at the CRP and flagship level are, by their very nature, generic. More granular ToCs would help identify barriers along the theory of change so that specific enabling actions can be initiated in time.
7. **For evaluating significant impact areas, RICE should engage team leaders from outside the CGIAR periphery.** This can give CGIAR donors more confidence about impacts being achieved. FP1 team members can continue to play strong roles. Several of these evaluations can be carried out as development evaluations, led and facilitated by external evaluators focused on learning and innovation in addition to accountability. Centers and projects commissioning impact evaluations should draw on the advice on rigorous impact assessment from SPIA, the Impact Assessment Focal Points, and the CAS independent evaluation function.
8. **In its 2020 annual reporting, RICE should consider capturing an extended summary of achievements and gaps related to the ToCs, at both the CRP and FP levels.** This information could help guide follow-on actions for 2021/22 and beyond and could sharpen the focus and continuity of CRP work along the scaling pathways.
9. **Improving the quality of science at the CRP would require three key interventions**: (1) IRRI and partners would need to resolve the imbalanced gender ratio in staffing, (2) RICE would need to reduce its non-open-access publications to increase reach to intended next users, and (3) RICE should consider merging FP4 and FP5 to increase synergy and efficiency in operation.

3.6 CGIAR System-Level Recommendations

1. **Greater CRP effectiveness is possible with better integration and a common framework of operation across CRPs and Centers**. CGIAR One should promote an approach of less entrenchment and more collaboration among the Centers and infuse private sector thinking. Funding modalities for cross-CGIAR Center partnerships would need to be reformulated to promote collaboration.
2. The **System Organization (SO) should clearly lay out the functions of independent steering committees** (ISCs), which are aligned with Center-level structures.

[9] For example, https://sitoolkit.com/.

3. **CAS should develop a project evaluation system within CGIAR.** In the CGIAR One System, an independent entity can take on the role of commissioning project evaluations of significant bilateral projects. These evaluations should be utilization-focused and follow a regime of evaluation quality standards. The project evaluations and management response should be published.
4. The **CGIAR System Office would need to review MARLO for its complexity and usefulness** among the Centers and programs that have adopted it. It can gather systematic feedback from the CRPs about the future shape of this CGIAR-wide system.
5. **CAS should complement the work of SPIA by supporting the CRPs in structuring impact evaluation systems led by external experts,** especially for significant impact areas. Impact assessments supported by SPIA should provide the model for rigorous impact assessment in CGIAR, highlighting practices such as matching with advanced research institutes to ensure proper balancing of interests in study teams.

4 Lessons Learned

While CGIAR CRPs, as an organizing principle or framework, have been successful integrating mechanisms to promote interdisciplinarity, common research agendas, and connections across flagships, they have experienced a trace of tension. Externally, the RICE CRP has been an increasingly effective mechanism for partnerships for science and its uptake, because it has strengthened collaboration with partners. However, for IRRI, the lead center, it has been a difficult management act. While all worked well in GRiSP times, some structural issues were observed in the RICE phase of the CRP. These issues are best discussed and managed internally by Centers, but the CGIAR System Office can also play a role. This is generic lesson coming out of this review; any specificity would be difficult to provide as this was not the focus of the review.

Given that bilateral projects last an average of 3.2 years, it is difficult for Centers and the CRP to manage expectations around upscaling within this period, although bilateral sources of funding are important (KIIs, dashboard data). The CRP and Centers should continue to work with donor partners who have taken a long-term visionary approach to addressing the grand challenges. This will not only provide funding stability but also help avoid a shorter-term or myopic view of the relevant systems (biophysical, social, policy, institutions, markets) in favor of long-term scaling pathways, which can obviously be segmented with short-term milestones.

RICE's experiences have generated lessons for collaborative approaches and opportunities. Several of RICE's technological innovations can promote CGIAR-wide collaboration (a satellite-based rice-monitoring system implemented by IRRI with partners in India and the Philippines, specific crop-monitoring systems using spatial technologies such as satellites, drones, mobiles by CIMMYT, ICRISAT, IWMI, and other CGIAR institutions). Expertise in this area, including personnel, infrastructure, and software, is demanding and costly. While it was beyond the purview of this review to determine the extent of resource sharing on path-breaking initiatives (such as satellite-based crop monitoring) across CRPs or Centers, the insights gathered through this review indicate there could be scope for improved collaboration on this front. Crop-growth models across institutions can be integrated. IRRI's microwave remote sensing and IFPRI's mobile-based application can be integrated. The Community of Practice on Crop Modeling (CoPCM) of the CGIAR Platform for Big Data in Agriculture can facilitate these integrations, if it has not already. Tamil Nadu Agriculture University (TNAU) is moving ahead with plans to use its experience with satellite monitoring of rice to monitor other crops and conditions. It is talking to ICRISAT on groundnuts and pulses, and IWMI on droughts and floods, although this collaboration has not yet been established.

5 Annexes

Find the Annexes and Brief here:

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