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GRiSP Extension proposal 2016

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CRP GRiSP

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1 Intermediate Development Outcomes, Theory of Change, and Impact Pathways

*Synthesis of the IDOs, theory of change, and impact pathways of the CRP, including explanation of how the CRP will contribute to common CRP IDOs and so to achievement of the SLOs. Include **CRP'S IDOS Table** presenting their respective targets and indicators and the specific metrics to be used for each indicator. Describe main change s that may occur over the next 9–10 years that may create discontinuities and influence the CRP's theory of change, partners, research questions, or choice of sites (4 Pages).*

GRiSP's mission is to reduce poverty and hunger and improve human health and nutrition in rice-dependent populations, and to reduce the environmental footprint and enhance the ecosystem resilience of rice production systems. It aims to achieve this by fostering high-quality, impact-oriented research and development activities at spatial scales ranging from local to national and to global. The extension of GRiSP in 2016 takes on board learnings from the first phase of GRiSP (2011-current) and prepares for the second phase expected to start in 2017. A major development is the formulation of Intermediate Development Outcomes (IDOs) and their relation to the CGIAR System-Level Intermediate Development Outcomes (SLIDOs) as summarized in Table 1. Quantified global aspirational targets are given in Table 2 (Annex 2) for 2020 and 2035. Some of our concrete outcome targets for specific geographic regions (action sites, see Annex 3) are given below for 2016–2022:

- By 2016, 60,000 direct "client households" in hubs around Jessore, Khulna, Barisal, Faridpur, Mymensingh, and Rangpur in Bangladesh have adopted improved varieties and improved and efficient natural resource management practices for rice, maize, wheat, fish, vegetables, and other high-value crops[1], which will increase their net income with US$350/household from 2012 level. In addition, through various dissemination-related activities such as demonstration and adaptive research trials, farmers' field days, and farmers' training activities, etc., another 300,000 households will be reached indirectly.
- By 2018, the adoption of improved rice varieties for irrigated conditions (transplanted and dry-seeded) and of improved crop management and postharvest practices by 4 million farmer households on 5 million hectares in South Asia (the western Indo-Gangetic Plain, the central Gangetic Plain, and the eastern Gangetic Plain in India, Bangladesh, Nepal, and Pakistan; and subtropical South India) will lead to a 0.5 t/ha increase in cereal yields.[2] Adoption by another 2 million farmer households in South Asia on 2.5 million hectares will lead to a 1 t/ha increase in cereal yield. At least 30% of adopters of improved varieties and production technologies are women, while at least 70% of adopters of improved post-harvest practices are women. The adoption of improved practices will increase nitrogen and water use efficiency by 30% compared to 2012 levels. At least 5 million tons additional grain will be produced annually, with an additional economic grain value of at least $1.5 billion per year and substantial other savings in terms of energy and other production costs.
- By 2018, 30 million poor smallholder rice farmers in Asia (Laos, Indonesia, Vietnam, Bangladesh, Sri Lanka, Pakistan, Philippines, India; and Guangxi, Sichuan, Yunnan, Guizhou, and Ningxia provinces of China) and Africa (Nigeria, Rwanda, Uganda, Mali, Mozambique, Senegal, Tanzania, and Ethiopia) have adopted Green Super Rice varieties, which increases their average rice productivity by 20%, and represents a collective income increase of about $1.3 billion per year. We aim to include 30% women among adopters.

[1] Joint results of the CRPs GRiSP, WHEAT, MAIZE, and AAS.

[2] The cereals are rice, wheat, and maize, and these are joint results of the CRPs GRiSP, WHEAT, and MAIZE.

- By 2019, 25 million farmers in South Asia (India, Bangladesh, and Nepal) and Africa (Nigeria, Benin, Senegal, Burkina Faso, Ghana, Guinea, The Gambia, Mali, Cote d'Ivoire, Guinea Conakry, and Sierra Leone in West Africa; Mozambique, Tanzania, Uganda, Ethiopia, Madagascar, Rwanda, Burundi, and Kenya) have adopted improved stress-tolerant rice varieties (for drought, salinity, and submergence) and accompanying management practices, resulting in an annual increase in income per farm family of 15% (affecting lives of over 100 million people), representing a collective increase of about $1.9 billion per year. About 86% of this increase would be in SA and 14% in SSA. The improved varieties will provide a yield advantage of at least 1 t/ha over the currently grown varieties on farmers' fields under stress conditions. We target at least 30% women involvement in all activities.
- By 2022, 0.5 million farmer households in Asia (Can Tho and Long An Province, Vietnam; Nakorn Sawan Province, Thailand; Guangdong Province, China; Ayeyarwady Region (Maubin, Bago), Myanmar; Polonnaruwa and Vaunia District, Sri Lanka; South Sumatera and Sulawesi, Indonesia) have adopted sustainable management and postharvest practices, which will lead to a 20% yield increase, 20% increased profitability, increased resource-use efficiency, and a decreased environmental footprint.

GRiSP's Impact Pathway (IP) and Theory of Change (ToC) (Annex 1, Fig. 1) are grounded in a historical evidence base,[3] which is taken forward through conceptual and quantitative foresight exercises (e.g., p 24-25 and 180-184 of the GRiSP proposal, and p 69-74, Boosting Africa's Rice Sector).

Rural poverty and hunger can effectively be reduced by increased agricultural growth through improved productivity and income. Productivity growth in the agricultural sector also contributes to growth of regional or national economies through "growth linkages," of which an important one is lowered prices of food. Increased productivity leads to increased rice production, which lowers food prices and makes rice more affordable to the poor, for whom rice is a "wage good." The input intensification associated with yield growth results in greater demand for labor and wages. Increased yield and productivity can be brought about by genetic improvement, improved natural resource management, and a combination of both. Genetic improvement consists of increasing the yield potential and/or increasing tolerance (or resistance to) of abiotic stresses (drought, submergence, salinity, extreme temperatures, problem soils) and biotic stresses (pests, weeds, diseases). Although the genetic potential of varieties determines the maximum yield farmers can obtain in a particular environment, their crop management (i.e., soil, water, nutrients, pests, and diseases) determines how much of this yield potential is actually realized. Pathways to increase farmers' income include raising productivity but also reducing the costs of production, increasing the value of production, decreasing postharvest losses, and—for both farmers and poor consumers—reducing expenditures on food (which increases net available income for other purposes). The costs of production can be decreased by improved management that lowers the use of inputs even while holding yield constant. The value of production can be increased by increasing the marketability of rice grains, and by increasing the value and use of by-products such as straw and husk. The value of rice grains can be

[3] For a full version, see the report "GRiSP Results-based program strategy and management framework, April 2013" (obtainable from the GRiSP office).

increased by enhancing physical (e.g., decreasing chalkiness, increasing head rice recovery) or eating quality (e.g., aroma, stickiness, cooking quality) for eating. Increased grain quality can be derived from genetic improvement (e.g., aromatic rice, less chalky rice) as well as from improved postharvest technologies. Finally, reduced expenditures on food can be realized through the lowering of the price of rice.

A direct pathway to increasing **food security** is by making staples more available and at lower costs through technological changes in agriculture, including enhancing the competitiveness of local production. A low price of rice makes it more affordable to net rice consumers in both rural and urban areas. Improved rural household food security can be realized through increased on-farm production and/or increased income (which translates into increased purchasing power). Many of the above-mentioned technologies to reduce poverty contribute to increasing rice food security as well. Enhanced overall productivity, better participation in the value chain, and diversification of farm output will protect farmers from an adverse impact of lower rice prices.

Nutrition and health: Human micronutrient deficiencies are relatively severe in areas where rice is the major staple. Increasing the density of provitamin A carotenoid, iron, and zinc in the grains of rice helps to alleviate these deficiencies, especially among the urban and rural poor who have little access to alternatives such as enriched foods and diversified diets. Improving the glycemic index (GI) of rice can potentially contribute to reductions in the incidence and ongoing treatment costs of Type II diabetes, which is reaching epidemic proportions among all population groups across South and Southeast Asia. Reduced pesticide use, through pest- and disease-resistant varieties and integrated pest management (IPM)/ecological engineering practices, helps to reduce health risks to farmers. Recently, the recognition of the presence of heavy metals such as cadmium and arsenic in grain produced from some rice production environments is emerging as health threat.

Sustainably managed natural resources: Different pathways exist by which agricultural research can increase the sustainability of rice production, reduce the use of precious resources (water, energy), increase ecosystem services, and reduce negative environmental externalities in rice production such as greenhouse gas emissions and loading of agrochemicals (including pesticides). Increasing the productivity of input use (e.g., water, energy, nutrients) reduces the amount of inputs used per unit production, and hence conserves these input resources. The increase in productivity can be realized through an increase in effective use, or uptake, of the input in question, and by an accompanying reduction in emissions to the environment. Some technological innovations directly target the reduction of negative externalities such as IPM, the use of pest- and disease-resistant varieties, and ecosystem engineering that aim to reduce the application of pesticides in rice landscapes by enhancing natural (bio)control functions and ecosystem resilience. Adapted water and soil management practices can reduce the emission of greenhouse gases. Crop diversification in rice-based cropping systems can also contribute to increased sustainability.

GRiSP develops—with its partners—products and services, such as genes and markers, breeding lines, improved varieties, improved crop management and postharvest technologies, policy briefs, and training and dissemination materials. Our

research to impact pathway for these products follows a "*pipeline*" approach: upstream research results in discoveries and innovations, which are translated into concrete products, which are tested, improved, used, and disseminated with *intermediate users*, and finally become adopted by *end users* (Fig. 1). Intermediate users encompass a variety of actors, such as research organizations, extension services, NGOs, and public- and private-sector parties. End users are typically actors along the rice value chain, such as farmers, millers, processors, traders, and consumers. End users can also be input suppliers, such as seed producers or the fertilizer industry (which make use of improved nutrient management guidelines). Partners play a key role in all stages of the pipeline, and there are many feedback and feed-forward loops among research, development partners, and users. In fact, the pipeline is not a linear model; the whole development, assessment, adoption, reassessment, and dissemination process is more like a web. Finally, the targeted results of adoption are the *outcome indicators* summarized in Table 1.

Many possible pathways toward adoption exist at different spatial scales, from local—our action sites—to national and to global. At each spatial scale, products may reach users directly through intermediate users operating at that specific scale, or they may reach users through the process of scaling out and scaling up from underlying spatial scales (Fig. 2). At action sites, GRiSP concentrates its R&D efforts "on the ground" with its partners. This can be research taking place at advanced laboratories, at key breeding locations (e.g., multienvironment trials), at experimental platforms, or at development sites where GRiSP-derived products and services are tested, evaluated, improved, and adapted. An example of development actions sites are the Rice Sector Development Hubs in Africa (Fig. 3). Products adopted at the local level (the action sites) can reach more users at larger spatial scales through processes of outscaling and upscaling. The Brookings/IFAD framework[4] emphasizes the importance of learning in an iterative and interactive cycle of scaling up. Following this framework, we recognize that scaling up pathways can follow different "dimensions." In its simplest form, scaling up may expand services to more clients in a given geographical space. It can also involve "horizontal" replication, from one geographic area to another. In "functional" expansion, additional areas of engagement are added to the existing ones. In "vertical" up scaling, activities move from a local or provincial engagement to a nationwide engagement, often involving policy dialogue to help achieve the policy and institutional conditions needed for successful national-level scaling up. Mindful of these various modes of scaling out and scaling up, GRiSP develops and strengthens the "*enabling environment*" for facilitating outcomes at—and across—spatial scales: it takes action to mobilize, strengthen (capacity for research, innovation, and extension), inform, support, and link partners, and to promote equity throughout the rice value chain—especially gender equity. Hence, our outcome indicators refer not only to the adoption and use of new

[4] Linn, Johannes F., Artntraud Hartmann, Homi Kharas, Richard Kohl, and Barbara Massler. 2010. *Scaling Up the Fight against Rural Poverty: An Institutional Review of IFAD's Approach.* Brookings Global Economy and Development Working Paper 43, October. Washington, D.C. (For the International Fund for Agricultural Development).

rice technologies (e.g., new varieties and management practices) but also to the *enabling environment* (e.g., capacity built, functional delivery systems, learning alliances, value chains, women's empowerment index, etc.). To identify the required enabling actions, we first establish the assumptions associated with each flow step along the selected impact pathway for the specific GRiSP product or service at hand (the middle part of Fig. 1 as generic example) and the risks if these assumptions are not met. From this analysis, we identify the enabling actions we need to undertake to minimize the risks and to ensure the upward flow of products (the right-hand side of Fig. 1). For each of GRiSP's Flagship Projects —and for some specific products—, impact pathways and supporting theories of change were developed to facilitate scaling up and scaling out. At larger spatial scales, such as the national level, GRiSP products may also be taken up, used, and disseminated directly by a variety of partners. Examples are published new genes and publicly available breeding lines that are used by plant breeders across the globe, or management technologies approved for official country-wide dissemination—without having gone through the process of spatial outscaling.

2 Flagship Projects

CRPs will deliver its work through a limited number of large "flagship projects" with a value of between US$20 and 100 million over the course of the program. Flagships may be either geographically or thematically focused. Summarize flagships and show how they will contribute to the IDOs (3 Pages).

Currently, GRiSP is composed of six highly interconnected Themes, which are subdivided into Product Lines. GRiSP's model is that of vertical integration along the rice value chain/research-development continuum. We link and integrate rice research and product development at the lowest spatial scale of molecular biology, through organ, plant, crop, field, farm, and region to the national and global level. In line with the proposed CRP-wide terminology, our Themes will morph into Flagship Projects, which each contribute to multiple IDOs (Fig. 4). To emphasize our focus on results, and to facilitate enhanced results-based management, we have re-formulated our Product Lines into concrete "*results*" that are delivered through clusters of activities. *Results* are defined by concrete products and services (outputs) and outcomes. This is comparable to our current Product Lines, though with increased focus on results as a management principle[5]. Taking on board lessons learned so far, and changes in the environment, we will refocus the current six Themes into five Flagship Projects. A main change is a new Flagship Project, called "Sustainable and efficient rice value chains," which includes and links the development and delivery of sustainable practices along the whole value chain from production to postproduction—from "spade to plate." This new Flagship Project acknowledges that sustainability and sound environmental practices are not limited to the process of rice production but should include all aspects of harvest and postharvest, such as drying, milling, transport, processing, and marketing—not only looking at rice

[5] Moreover, the move from "management of activities" to "management of results" is promoted by the CGIAR Consortium.

grains but including rice by-products as well. In this new Flagship Project, elements of current Themes 3 and 4 are combined and expanded with a new focus on integrated value-chain thinking (as also reflected in our IDO #3, Table 1). The proposed Flagship Projects and their *results* follow:

Flagship Project 1: Harnessing genetic diversity
- Result 1.1. Conserved (*ex situ*) and disseminated rice germplasm
- Result 1.2. Enhanced genetic diversity
- Result 1.3. Genes conferring productivity, stress tolerance and value-addition traits
- Result 1.4. C_4 rice

Flagship Project 2: Developing improved rice varieties
- Result 2.1. Modern breeding tools
- Result 2.2. Germplasm stock containing valuable traits
- Result 2.3. Stress-tolerant rice varieties
- Result 2.4. Rice varieties for intensive production systems
- Result 2.5. Hybrid rice
- Result 2.6. Healthy rice
- Result 2.7. Rice with enhanced market value

Flagship Project 3: Sustainable and efficient rice value chains
- Result 3.1. Future intensive systems
- Result 3.2. Diversified farming systems
- Result 3.3. Management systems for stress-prone areas
- Result 3.4. Management systems adapted to climate change
- Result 3.5. Improved postharvest, processing, and marketing technologies
- Result 3.6. Innovative uses of rice straw and husk

Flagship Project 4: Technology targeting and evaluation
- Result 4.1. Socioeconomic and gender analyses
- Result 4.2. GIS tools to optimize rice technology development and delivery
- Result 4.3. Global rice information gateway
- Result 4.4. Foresight and impact assessments

Flagship Project 5: Outscaling and capacity building
- Result 5.1. Innovation and advisory systems
- Result 5.2. Effective outscaling mechanisms in South Asia
- Result 5.3. Effective outscaling mechanisms in Southeast and East Asia
- Result 5.4. Effective outscaling mechanisms in Africa
- Result 5.5. Effective outscaling mechanisms in Latin America and the Caribbean (LAC)

Each Flagship Project includes gender components in its research, product development, and delivery (section 3). Flagship Projects 1 to 3 develop science-based products that contribute to the sustainable increase in productivity along the rice value chain that was identified as a key driver for reducing poverty, increasing food security, increasing health and nutrition, and improving the sustainability of natural resources. Under Flagship Projects 4 (targeting and evaluation) and 5 (outscaling and capacity building), we facilitate and speed up the outcome and impact processes (*enabling actions*).

Flagship Project 1 (harnessing genetic diversity) develops prebreeding tools and products that will be used by geneticists and breeders to increase the effectiveness of breeding new rice varieties. We connect with top-quality and leading advanced research institutes worldwide to ensure that GRiSP remains at the frontier of technology

development. Within GRiSP, results from Flagship Project 1 feed into Flagship Project 2. We develop architectures that will enable us to systematically access diversity. We also create new diversity itself, through, for example, the use of new tools such as mutagenesis and TALENS (Transcription Activator-Like Effector Nucleases) and the development of MAGIC (Multiparent Advanced Generation Inter-Cross) and NAM (Nested Association Mapping) populations. We discover and validate SNPs, QTLs, and genes, and develop markers linked to important traits for use in variety development. Gene discovery is mostly geared toward increased productivity (including yield potential), resistance/tolerance for biotic and abiotic stresses, and value addition. By 2016, our C_4 project will have delivered proof of concept and will enter the next phase of product assembly.

Flagship Project 2 (variety development) develops and tests new breeding tools and new rice varieties with improved properties, such as increased yield potential, tolerance of/resistance to biotic stresses (pests, diseases, weeds) and abiotic stresses (drought, submergence, salinity, heat and cold tolerance, problem soils), improved grain quality, and enhanced nutritional value. We combine tolerances of multiple stresses by gene pyramiding, such as drought tolerance with submergence tolerance. Improved quality encompasses a range of properties that meet increasingly sophisticated and local-specific consumer demands, such as taste, aroma, texture, shape, color, and cooking and processing properties. Especially driven by the increasing size of the middle-income group in Asia, rapid urbanization, and increase in rice trade, quality demands are rapidly changing in time and space. We root our product development in consumer demand inventoried and mapped in collaboration with Flagship Project 4. In terms of healthy and nutritious rice, we develop rice that is high in micronutrients (provitamin A, Fe, Zn) and that has a low glycemic index. Our strategy is to "mainstream" (incorporate) healthy and nutritious properties in all major germplasm released and shared with our partners. The development and dissemination of new rice varieties take place in close collaboration with our national and private-sector partners through strong networks and consortia such as the International Network for Genetic Evaluation of Rice (INGER), the Latin American Fund for Irrigated Rice (FLAR), the Hybrid Rice Research and Development Consortium, the Hybrid Rice Consortium for Latin America (HIAAL), the Africa-wide Rice Breeding Task Force, and the project Stress-Tolerant Rice for Africa and South Asia (STRASA).

Under Flagship Project 3, we develop and deliver improved technologies along the rice value chain for rice production and postproduction. We develop sustainable natural resource management technologies that enable more efficient use of land, labor, water, nutrients, and energy and thus reduce the cost of production as well as its environmental footprint. We specifically develop water-saving technologies to help cope with increasing global water scarcity, as well as management options to cope with climate change and to reduce the emission of greenhouse gasses (in collaboration with CCAFS). We develop and implement principles of ecological pest management to control increasing incidences of insect pests and weedy rice. With increasing labor scarcity and labor wages, we develop and promote labor-saving mechanization options such as direct seeding and mechanized transplanting, and combine those with principles of

conservation agriculture. Production practices are optimized within the context of whole-farm and diversified cropping systems, including on-farm aquaculture (in collaboration with MAIZE, WHEAT, and AAS). We develop new management practices and new cropping systems that exploit the potentials of new varieties developed in Flagship Project 2. In the postproduction chain, we work with farmers and service providers—especially small and medium enterprises (SMEs)—to develop and implement improved postharvest operations such as hermetic storage, improved drying, parboiling, and milling. The aim is not only to reduce the (often substantial) postharvest losses but also to increase added value through quality improvement and the use of by-products such as straw and husk (e.g., mushroom substrate, energy generation, biochar). We link actors (including farmers) along the rice value chain to improve whole-chain efficiency. We work with colleague researchers from our NARES partners as well as with farmers (on-farm participatory R&D), service providers, and other private-sector partners. Important mechanisms for collaboration are the Latin American Fund for Irrigated Rice (FLAR), the Irrigated Rice Research Consortium (IRRC), the Consortium for Unfavorable Rice Environments (CURE), the Africa Agronomy Task Force, the Sustainable Rice Platform (SRP), and the project Cereal Systems Initiative for South Asia (CSISA).

Flagship Project 4 provides gender-disaggregated and critical feedback to all the other GRiSP Flagship Projects, helping these develop well-targeted and demand-driven products and delivery approaches. This Flagship Project also houses the cross-cutting gender research activities (section 3). Core activities involve the collection, management, and analysis of household survey data to provide insight into constraints to adoption, technology targeting, monitoring and evaluation, adoption, and (ex ante and ex post) impact assessment. A market research and value-chain team provides support to Flagship Projects 2 and 3 in product profiling, market segmentation, and market analysis. We develop a Rice Monitoring System to provide real-time area, yield, and production estimates for Asia by combining modern techniques such as satellite-based remote sensing with weather information and crop modeling. We maintain an integrated modeling platform for ex ante assessment, food security, and policy analysis (collaborative activity with PIM). Our tools generate market information that includes trade leads, local prices, policy updates, export quotations, export tenders, seasonal price forecasts, currency market analysis, and trade flows.

Under Flagship Project 5, we facilitate capacity building, strengthening of extension and advisory services, and the scaling-up of GRiSP products and services to reach "impact at scale." Hence, there is very close interaction between Flagship Project 5 and all other GRiSP Flagship Projects. Taking results from Flagship Projects 2 and 3, we develop innovative learning and communication tools; web and mobile phone-based advisory services; rice information systems such as the Rice e-Hub tool, the Rice Knowledge Bank, and Ricepedia (in development); and training videos, including some that are co-produced with Digital Green. Partners are trained in the design and use of such tools and stimulated to develop locally adapted versions, such as the national Rice Knowledge Banks. Together with partners, we foster innovation by developing learning alliances and multistakeholder platforms. As technical know-how in "traditional" disciplines such as plant breeding, agronomy, soil, water, pest, and disease management,

etc., is rapidly dwindling in Asia and spread extremely thin in Africa, we increasingly invest in capacity building through degree training and targeted courses. On an annual basis, we aim to deliver around 100 rice experts at the graduate and postgraduate levels, and—together with our partners—strengthen the capacity of 10,000 to 15,000 local experts through short-term courses. We also invest in capacity building of our own GRiSP staff, for example, on project management, leadership, scholar supervision, and gender and cultural diversity. In collaboration with the public, private, and civil society sector, we develop improved delivery systems for seeds, crop and postharvest management information, and policies. A novel activity is the facilitation of business model development to assist SMEs with the production and use/marketing of new technologies, such as improved storage facilities, dryers, parboiling equipment, laser levelers, and threshers. Important collaborative mechanisms for upscaling and capacity building are the Latin American Fund for Irrigated Rice (FLAR), the Irrigated Rice Research Consortium (IRRC), the Consortium for Unfavorable Rice Environments (CURE), the Rice Sector Development Hubs in Africa, and projects such as the Cereal Systems Initiative for South Asia (CSISA). GRiSP operates a special graduate and post-graduate scholarship program, the Global Rice Science Scholarships (GRISS).

3 Gender

Synthesis of most important achievements expected in (a) integration of gender into research (see relevant indicators in the CRP Annual Performance Monitoring Report, annex 2) and (b) gender in the workplace (1 Page)

GRiSP developed an iterative gender strategy that is based on a specific impact pathway and theory of change on how the empowerment of women in the agricultural research for development (AR4D) arena and in the rice value chain (women farmers, postharvest operators, processors) accelerates the delivery of GRiSP's intermediate development outcomes. The term "empowerment" integrates the strengthened role of women in the design, execution, and evaluation of AR4D, as well as improved access to resources (e.g., production inputs, knowledge, pro-gender improved technologies) and control over outputs (harvested rice, processed rice, derived income). We recognize that enhanced empowerment of women will take place only after substantial *transformative* changes have taken place in the mind-sets and behaviors of all actors in the AR4D arena and in the rice value chain, from the grass-roots to leadership levels, among both men and women. Hence, our gender strategy also includes important components of capacity building and training. GRiSP's IDO 6 explicitly includes the improvement of gender equity in the rice sector, recognizing the heterogeneity of rice economies across regions. For example, LAC is a relatively large-scale commercial rice production environment; Africa is small scale, with farmers increasingly commercial and competing with Asian imports; whereas Asia has an extremely diverse set of traditional rice-based cultures. The global GRiSP seeks to create a scientific product- and services-based program that weaves these together. Within this context, all GRiSP Flagship Projects have identified specific entry points to enhance gender equity and promote women's empowerment. In

Flagship Projects 2 and 3, we identified main entry points for technology development and delivery that respond to gender-specific needs and preferences: new rice varieties, labor-saving and drudgery-removing practices, postharvest technologies, and business and marketing skills. Cross-cutting and synthesizing gender-specific research is housed in Flagship Project 4, whereas the promotion of transformational changes is specifically addressed in Flagship Project 5. For example, we strengthen women's leadership and agribusiness skills, train women in the delivery of agrotechnologies, target women in training on seed preservation technologies, include women in the development and selection of new rice varieties, specifically reach women as beneficiaries of new stress-tolerant varieties, strengthen women's groups in branding and selling rice, and help former combatant women to re-integrate in society through rice production activities. We facilitate transformative changes through the development and dissemination of policy briefs, awareness raising, advocacy events, inclusion of gender aspects in planning workshops, training of own staff and NARES partners on gender and diversity, and working with our NARES partners in developing gender RD&E action plans.

4 Partnerships

CRP's ToCs depend on effective partnerships and it is therefore anticipated greater detail on how the CRPs are working through partnership to achieve the IDOs. Highlight partnership successes to date and how these will be built on in the coming phase, preferably being explicit about the role of partners in research (e.g., leadership on components, management and governance, membership of steering or management committees, etc.). Synthesis of main changes in CRP governance, structure, partnerships that will be implemented between 2015 and 2016. Indicative shares of budget, by partner or partner category, would be desirable (2 Pages).

The recent GRiSP Partnership report gives a detailed overview of GRiSP's diverse partnership arrangements. GRiSP strategizes and aligns the rice research for development agenda of its six founding and coordination partners: the International Rice Research Institute (IRRI, the lead institute), Africa Rice Center (AfricaRice), International Center for Tropical Agriculture (CIAT), the Centre de Cooperation Internationale en Recherche Agronomique pour le Développement (Cirad), L'Institut de Recherche pour le Développement (IRD), and the Japan International Research Center for Agricultural Sciences (JIRCAS). Together, they align and bring to the table mature and highly effective consortia, networks, platforms, programs, and collaborative projects with more than 900 partners from the governmental, nongovernmental, public, private, and civil society sectors. In total, around 17% of the total GRiSP budget of the CGIAR centers flows through to non-CGIAR partners.

GRiSP is managed by its Program Planning and Management Team (PPMT), which is chaired by the GRiSP director and in which each coordinating partner has a representative from senior management: the Deputy Director General of AfricaRice, the Deputy Director General for Research of IRRI, Director levels at CIAT, IRD, and JIRCAS, and senior researcher at Cirad. This high-level representation at the GRiSP management

level facilitates effective management of GRiSP by—and within—the coordinating partners as these members are in a position to implement decisions taken by the PPMT. Governance is provided by the Board of the lead center, IRRI, and by a GRiSP Oversight Committee, which has a significant representation of external experts, and is chaired by an independent external expert. Center representation draws on the boards of participating centers, while the DGs of IRRI and AfricaRice are members *ex officio*. The recently concluded Review of CGIAR Research Programs' Governance and Management rated the GRiSP OC as having high independence. Moreover, the 2013 internal audit of implementation and management of CGIAR Research Programs at IRRI headquarters gave the overall implementation and management of CRPs the highest rating possible. Therefore, we propose to continue with the current governance and management structures. Besides our Oversight Committee, GRiSP partners and external experts contribute to planning and implementation processes through the many steering and advisory committees of the various substructures embedded within GRiSP.

GRiSP is implemented through a variety of subpartnership arrangements that evolve in size and composition across the impact pathway from upstream research, through product development, to extension and adoption, and to realizing IDOs and impact "at scale" (Fig. 5). Typically, the partnership share of pure research partners decreases going from upstream research and basic product development (at the left of the diagram) to dissemination and delivery (at the right of the diagram), while the partnership share of development partners increases. It is important to note, however, that both types of partners, along with various types of beneficiaries, are included at all stages along the impact pathway (especially in the design phase of product development) to ensure relevance to stakeholders' needs.

The private sector is rapidly growing in importance in the rice world, and private sector engagement is part and parcel of our research-for-impact strategy. GRiSP seeks out novel and creative ways to engage with the private sector, where it ensures its ability to deliver according to its mission under appropriate terms and conditions. We have four main mechanisms to engage in public-private partnerships. Through Scientific Knowledge Exchange Programs (SKEPs), we engage in joint R&D on specific topics such as prebreeding, research tool development (e.g., survey tools for pest and disease monitoring), technology development (e.g., drying equipment, parboiling), and information generation (e.g., rice production forecasts). Second, the private sector is becoming one of GRiSP's key vehicles to disseminate and encourage adoption of its technologies, such as new rice varieties, management recommendations, and postharvest technologies. The Asian and Latin American hybrid rice consortia are examples that embody both mechanisms. Third, we work with local small and medium enterprises to develop business models for GRiSP technologies, especially in the field of postharvest. Fourth, we engage in capacity building with the private sector through staff training—either directly through courses or as a result of the private sector hiring scholars, PDFs and other staff trained at GRiSP institutes. A new public-private partnership that encompasses a few of the above functions is the Sustainable Rice

Platform: a global multistakeholder platform, co-convened by the United Nations Environment Programme and IRRI, to promote resource efficiency and sustainable trade flows, production and consumption operations, and supply chains in the global rice sector. Partners include the food sector, international traders, agro-input suppliers, public R&D, and national government agencies.

GRiSP collaborates with the MAIZE and WHEAT CRPs in strengthening cereal-based crop production systems in South Asia; with AAS and WLE in optimizing the use of aquatic resources in Bangladesh and Myanmar; with PIM in evaluating poverty and food security impacts of new rice technologies; with A4HN through the delivery of nutritious "high-zinc" rice; with the Genebank CRP on activities to enhance the quality, effectiveness, scope, and global use of the rice germplasm collection; and with CCAFS on the development and delivery of climate-change-proof rice technologies and rice technologies that mitigate greenhouse gas emissions. Collaboration with these CRPs is mainly done through large cross-cutting projects (e.g., CSISA, Global Futures, HarvestPlus). GRiSP focuses on the development of novel technologies at the level of plant (and below), field, crop, and farm, whereas the other CRPs look at larger geographic scales and at the wider enabling environment (e.g., policies and institutions).

5 Regional collaboration

As part of the partnerships discussion each CRP should show how they are working with regional partners to pursue effective regional processes through which the CRPs can achieve greater impact at scale (1 Page).

GRiSP employs several mechanisms to align itself with priorities and strategies of its main national partners. In Asia, IRRI holds individual consultative planning meetings every 2 to 3 years with most of the Asian countries. For example, in 2013, the 4-year India-IRRI work plan was fully aligned with GRiSP, including allocation of ICAR funds to GRiSP activities in India. AfricaRice is an autonomous intergovernmental association of 25 member countries covering West, Central, East, and North Africa. Its objectives, strategies, and research activities are aligned with those of its member states and are approved by the AfricaRice Council of Ministers. Each year, the meeting of AfricaRice's national experts (the National Expert Committee (NEC) composed of NARES directors-general of the 25 member countries) is an important mechanism for the alignment of work plans with national priorities and programs. In Latin America, the Latin American Fund for Irrigated Rice, which is convened by CIAT and includes 17 member countries, is the main mechanism for both national and regional coordination.

GRiSP interacts closely with all major regional fora and economic communities that have a stake in the development of the rice sector. In 2011, the 33rd meeting of the ASEAN Ministers on Agriculture and Forestry (AMAF) communicated that it "*supported the Global Rice Science Partnership (GRiSP) … as it represents an important expansion and development of 2008's ASEAN Rice Action Plan*." The Council for Partnership on Rice Research in Asia (CORRA), convened by IRRI and including senior representatives from

research institutions of all Asian rice-producing countries, is an important regional advisory body of GRiSP. In 2013, the Rice Research and Training Center for Central and West Asia became active as a GRiSP network with its first training activities on rice research, hosted by Iran. GRiSP's coordinating centers also maintain close collaboration and interactions with broader regional fora, such as FARA, FORAGRO, and APAARI at the continental level, and CORAF and ASARECA in Africa at the subregional level; higher-level political bodies and development initiatives targeting food security and poverty, such as CAADP (NEPAD), CARD, ASEAN, and SAARC; Regional Economic Communities such as ECOWAS; and international and regional development funds and banks, including IFAD, the World Bank, ADB, and AfDB (many of those contribute directly as donors to GRiSP through bilateral projects).

6 Work plan 2016

Provide current best sense of the future development of the CRP a phased work plan for the period 2015-2016. This will necessarily be written at a high strategic level, but also should aim to convey what type of change is expected to happen, at what time, and when we expect to see results at different scales. For example, you might show that you envisage the CRP expanding into new geographies or developing new product lines (2 Pages).

The year 2016 will be an intermediate year between the end of the current (5-year) phase of GRiSP by December 2015 and the anticipated next phase that will start in 2017. Staying within the overall framework of a vertically integrated program, we propose to implement changes in response to experience obtained in the current 3 years and to major drivers of change (such as accelerated structural transformation in certain regions in Asia, increased urbanization and growth of the middle-income sector and consequent shifts in consumer preferences, increased presence of the private sector in the rice economy, increased emphasis on development outcomes). The most significant change/new element of GRiSP in 2016 will be its transition to a more outcome-driven and results-based management, based on the development and delivery of science-based products and services (Annex 3). Our medium- and long-term outcomes are given in Tables 1 and 2, and, based on results reported in 2013,[6] GRiSP is well on its way to achieving these outcomes.

In 2016, we will implement a new results framework as an outcome of our "fast-track project" on developing a results-based M&E system. The first step toward results-based management is the definition of results and the operationalization of a system to collect and evaluate—on a regular basis—indicators of progress. The results of GRiSP are defined as its concrete products and services (including their underlying scientific achievements), their dissemination and adoption, and the outcomes of adoption. Hence, GRiSP's *results* are its product pipelines that encompass both outputs and development outcomes. The associated output and outcome indicators are key to managing for

[6] GRiSP 2013 Annual Report.

results. In terms of *output indicators*, each year, around 100 milestones are defined for all Products of GRiSP. These are tracked, evaluated, and refined on a yearly basis. Additionally, each Flagship Project will have defined (by 2016) a few key output indicators that track the efficiency of the product development pipeline. For example, *genetic gain* obtained in multilocation trials is a proposed output indicator in the breeding pipeline of Flagship Project 2. In terms of *outcome indicators*, we will first have established (by 2016) a register of national-level rice development strategies and aspirational outcome/development targets for the main rice-producing countries. We will have an operational system to track national indicators of progress ("benchmark indicators") and specific contributions made by GRiSP. We will have defined *key action sites*/areas in Africa, Asia, and LAC, with aspirational outcomes and an operational system for collecting indicators of progress for which GRiSP and its partners share responsibility. Besides these key action sites, we will have a number of additional action sites that broaden the spatial scope of GRiSP and serve more specific objectives. Indicators will track and quantify GRiSP's contribution toward product delivery/uptake by end users and intermediate users, and toward fostering the enabling environment for outscaling and for improvement of gender equity, capacity, and resilience of the rice sector. These GRiSP outcome indicators define GRiSP's *contribution* toward our IDOs, and they will be complemented by rigorous impact and adoption studies that will quantify GRiSP's *attribution*.

In 2016, we will also considerably step up our gender R&D activities. We will have a system in place by which impacts of GRiSP technologies on adopters are gender disaggregated, and consequences of adoption for women made explicit. We will actively promote gender equity and women's empowerment by strengthening women's agribusiness skills along the rice value chain, notably in the production and marketing of quality seed, in branding and marketing quality rice, in parboiling and marketing parboiled rice, and in the delivery of advisory and other services such as mechanized transplanting and postharvest operations.

Some other salient new activities/results follow:

- In 2016, we expect to complete a major restructuring of our breeding programs, aimed at significantly enhancing efficacy and efficiency at producing and delivering improved rice varieties. This restructuring will also strengthen the integration between pre-breeding activities done in FP1 and the variety development taking place in FP 2. We will mainstream the pyramiding of multiple stress tolerances and the inclusion of nutritious traits into all our breeding pipelines. For example, any discovered genes or QTLs that confer high density of nutritious elements (zinc, iron, other traits) will be included in all major breeding lines and new varieties shared with our partners so that these traits will permeate national breeding programs, leading to massive and rapid global uptake of nutritious rice "by default" (dovetailing with A4HN delivery strategies for health and nutrition). Similarly, genes and QTLs—mainly discovered in FP 1—conferring tolerance of abiotic stresses (e.g., submergence,

drought) and biotic stresses (pests, diseases) will be pyramided into new varieties targeted for release into stress-prone areas. Since tolerances of stresses such as drought, submergence, and salinity confer adaptation to some of the major consequences of climate change, these GRiSP products mainstream the delivery of rice varieties adapted to climate change (dovetailing with CCAFS strategies for climate change adaptation). Finally, new genetic populations such as NAM and MAGIC will be fully exploited and used in variety development.

- Establishment and use of a new Genetic Diversity Platform that enables the prediction of gene-phenotype relations—based on comprehensive data of 3,000 genomes and their phenotypes—by an International Rice Informatics Consortium. Genotypic and phenotypic information of the 3,000 accessions will be made available through this new consortium. This will significantly speed up the discovery of new genes and improved variety development. We will conduct high-density genotyping, enable the use of high-density markers by breeders, and integrate this information into our breeding pipelines. Finally, we aim to expand the collection of 3,000 genomes to 10,000—which will be a key vehicle to capture nonCGIAR global investments in rice genetics.
- Development and deployment of a suite of modern ICT-based decision support systems for improved crop management. Web- and cell-phone-based media will be used to reach farmers and advisory agents from the public and private sector with information that can help them increase yield and profitability while reducing the environmental footprint and adapting to climate change. We will include criteria for sustainable rice production as defined through the global Sustainable Rice Platform.
- Development and deployment of a near-real-time information system on national rice production (area, yield, cropping calendar) in Asian countries. Governments, policymakers, and traders will use the information provided by this system to increase the efficiency of trade and add stability to domestic rice economies.

The above is a mere snapshot of GRiSP's activities and results in 2016; more details are provided in Table 3 (Annex 2).

7 Budget 2016

Best estimates of cost of each of the flagship projects and each of the IDOs should be provided until December 2016. It is understood that there will not be a detailed life-CRP budget, and that not all CRPs have a good sense of the costs of each IDO, but it is expected that CRPs will share their current best estimates for budgets until 2016 (2 Pages).

GRiSP phase I was approved for 5 years, from January 2011 till December 2015, with a total budget of US$593.39 million, composed of $382.69 million in Windows 1 and 2 and $210.70 million in Window 3 plus bilateral. The extension proposal for 2016 was mandated by the FC as a bridging mechanism until phase II CRPs would start in 2017. Our total budget for 2011-16 is derived from our current best estimates of W3 and

bilateral funding, plus a continuation of the 10%/year increase in W1 and 2 funding as in the approved Financial Plan in 2014-15 into 2016:

	2011	2012	2013	2014	2015	2016	Total
W1/2	34.32	35.40	34.50	37.72	41.44	44.92	228.30
W3 & Bilateral	62.86	63.66	60.37	61.53	65.28	69.29	382.99
TOTAL	**97.18**	**99.06**	**94.87**	**99.25**	**106.72**	**14.21**	**611.29**

The 2016 detailed results-based budget for 2016 follows:

	W1/2	**W3 plus bilateral**	**Total**	**Gender**
Result 1.1. Conserved (*ex situ*) and disseminated rice germplasm	1,687	689	2,376	-
Result 1.2. Enhanced genetic diversity	2,473	982	3,455	-
Result 1.3. Genes conferring productivity, stress tolerance and value-addition traits	2,798	2,311	5,109	-
Result 1.4. C_4 rice	943	4,810	5,753	-
Total Flagship Project 1: Harnessing genetic diversity	**7,901**	**8,792**	**16,693**	-
Result 2.1. Modern breeding tools	3,719	6,440	10,159	-
Result 2.2. Germplasm stock containing valuable traits	2,690	3,571	6,261	-
Result 2.3. Stress-tolerant rice varieties	3,626	10,147	13,773	1,377
Result 2.4. Rice varieties for intensive production systems	1,814	7,214	9,028	903
Result 2.5. Hybrid rice	1,125	986	2,111	211
Result 2.6. Healthy rice	826	1,924	2,750	275
Result 2.7. Rice with enhanced market value	673	2,668	3,341	334
Total Flagship Project 2: Developing improved rice varieties	**14,473**	**32,950**	**47,423**	**3,100**
Result 3.1. Future intensive systems	2,251	3,204	5,455	545
Result 3.2. Diversified farming systems	1,065	2,446	3,511	351
Result 3.3. Management systems for stress-prone areas	2,852	4,771	7,623	762
Result 3.4. Management systems adapted to climate change	1,021	410	1,431	143
Result 3.5. Improved postharvest, processing, and marketing technologies	658	1,372	2,030	304
Result 3.6. Innovative uses of rice straw and husk	287	225	512	-
Total Flagship Project 3 Sustainable and efficient rice value chains	**8,134**	**12,428**	**20,562**	**2,106**
Result 4.1. Socioeconomic and gender analyses	917	1,743	2,660	2,659
Result 4.2. GIS tools to optimize rice technology development and delivery	471	763	1,234	-
Result 4.3. Global rice information gateway	1,403	1,630	3,033	910
Result 4.4. Foresight and impact assessments	323	262	585	175
Total Flagship Project 4: Technology targeting and	**3,114**	**4,398**	**7,512**	**3,744**

evaluation				
Result 5.1. Innovation and advisory systems	910	1,711	2,621	393
Result 5.2. Effective outscaling mechanisms in South Asia	202	5,440	5,642	846
Result 5.3. Effective outscaling mechanisms in Southeast and East Asia	101	408	509	-
Result 5.4. Effective outscaling mechanisms in Africa	870	2,909	3,779	567
Result 5.5. Effective outscaling mechanisms in Latin America and the Caribbean (LAC)	60	254	314	-
Total Flagship Project 5: Outscaling and capacity building	**2,143**	**10,722**	**12,865**	**1,806**
New Frontier Projects	1,876	-	1,876	-
Institutional capacity building	3,019	-	3,019	1,057
Program coordination	3,650	-	3,650	-
Special gender studies	605	-	605	605
Total GRISP	**44,915**	**69,290**	**114,205**	**12,419**

All Flagship Projects contribute to several IDOs (Annex 1, Fig. 3, Table 4). For example, our impact pathway (Section 1) demonstrates that the yield increase through genetic improvement (Flagship Projects 1 and 2) contributes to increased food security (IDO 1), reduced poverty (IDO 2), and increased resource-use efficiency (IDO 3). Varieties with increased tolerance of heat, submergence, drought, and salinity are adapted to future climates and hence also contribute to IDO 4. In addition, nutritious varieties contribute to IDO 5. Hence, it is not possible to uniquely assign budgets of GRiSP's Flagship Projects to IDOs.

Some 63% of the total budget originates from W3 plus bilateral through specific projects funded by donors (usually through competitive processes). The distribution of the budget between W1,2 and W3 plus bilateral is guided by pragmatism to "get the job done" or "to get the result delivered". For example, the result "1.4 C4 rice" receives substantial funding through bilateral grants, and hence, the allocation of W1,2 funds can be relatively small. On the other hand, results such as "1.1. Conserved (*ex situ*) and disseminated rice germplasm" and "1.2 Enhanced genetic diversity", receive less bilateral grant funding and, hence, we have allocated relatively more W1,2 funding to these results. Also, with limits on W1,2 funds received (approved), bilateral funding is the only mechanism available to expand activities and the delivery of results. Finally, it should be noted that GRiSP does not decide to allocate bilateral funding to specific results or Flagship Projects; it is a specific donor decision to fund specific activities and/or results.

8 Annex 1. Figures

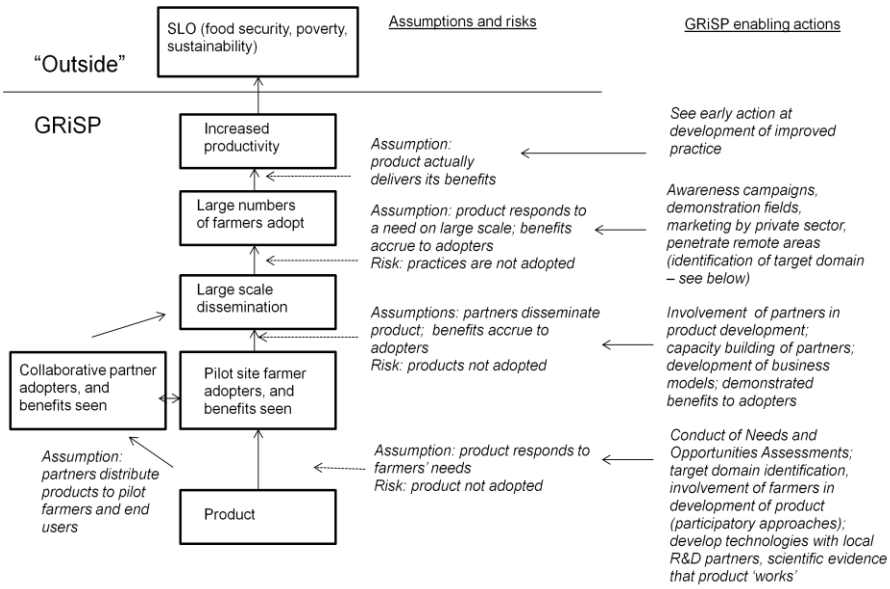

Fig. 1. Generic Theory of Change of GRiSP associated with an impact pathway leading to the IDO indicator "increased productivity."

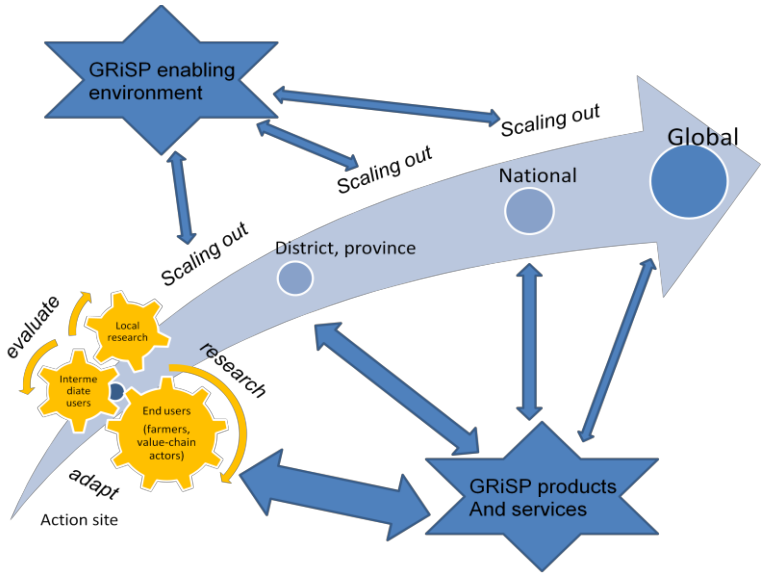

Fig. 2. Schematic diagram showing how GRiSP products and services are taken up, adapted, used, and disseminated at different spatial scales. GRiSP strengthens the enabling environment for outscaling and product uptake across spatial scales.

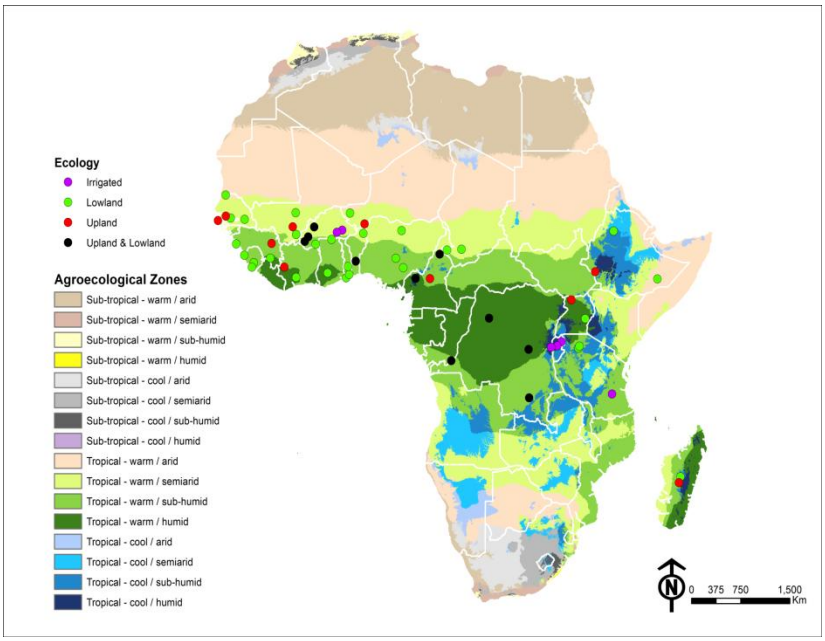

Fig. 3. Key GRiSP action sites in Africa: Rice Sector Development Hubs.

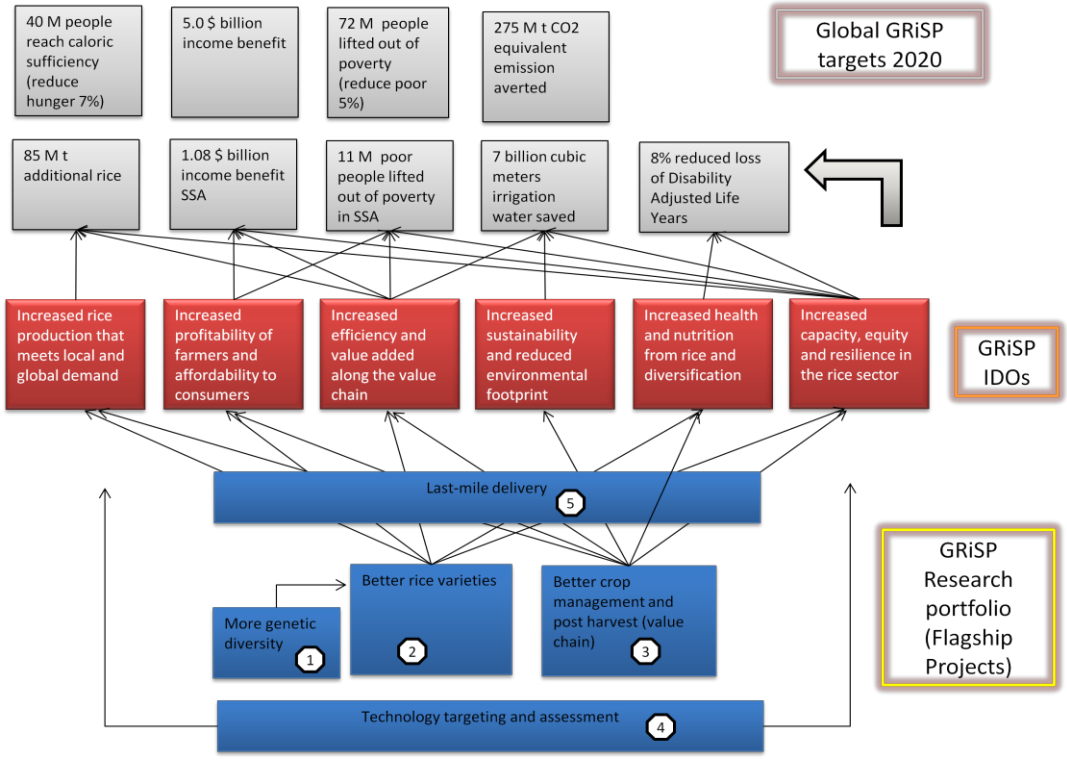

Fig. 4. Diagram showing how GRiSP's Flagship Projects contribute to the IDOs and global targets for 2020.

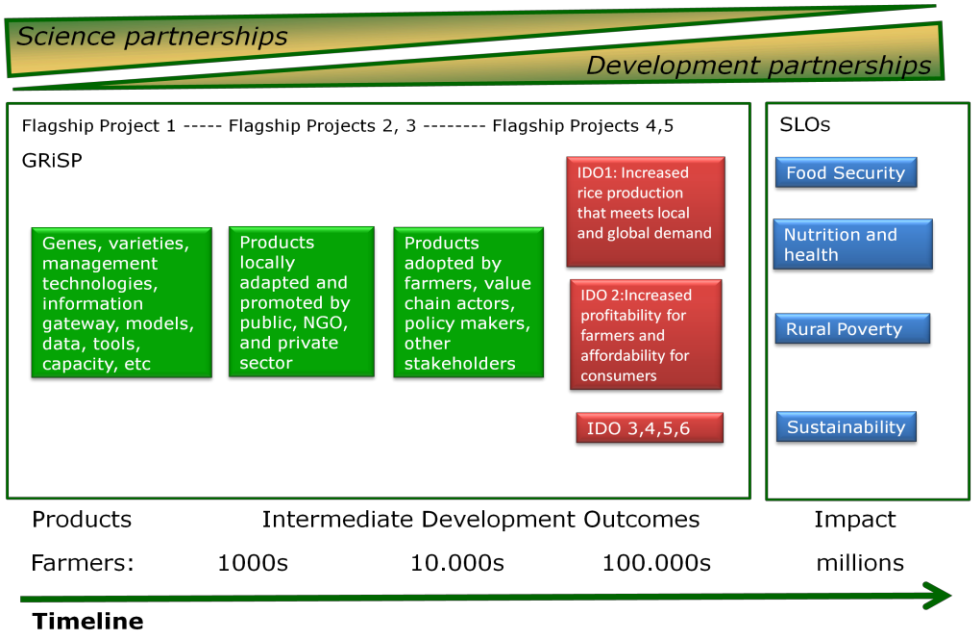

Fig. 5. Diagram illustrating how GRiSP's partnership composition changes along the impact pathway.

9 Annex 2. Tables

9.1 Table 1. GRiSP IDOs and their indicators, and the SLIDOs they contribute to.

IDO	SLIDO	Indicator
1. Increased rice production that meets local and global demand	1. Productivity—improved productivity in pro-poor food systems 2. Food security—increased and stable access to food commodities by rural and urban poor	• Global: production, consumption, and import/export volumes; rice area; average yield; International rice price. • National: production, consumption, and import/export volumes; rice area; yield; yield gap; domestic rice price. • Action site: yield; yield gap; adoption rates of improved rice varieties and practices to close yield gap; adoption rates of practices and machinery to reduce postproduction losses
2. Increased profitability for rice producers and increased rice affordability for consumers	4. Income—increased and more equitable income from agricultural and natural resource management and environmental services earned by low-income value-chain actors	• Global: rice price; economic producer and consumer surplus (modeled) • National: rice price; economic producer and consumer surplus (modeled) • Action sites: cost of production; local rice price; farmer profitability; adoption rates of improved rice varieties, production and postproduction practices
3. Increased efficiency and value added along the rice value chain	1. Productivity—improved productivity in pro-poor food systems	• Global: rate of mechanization along the rice value chain; cropping intensity in irrigated areas • National: price of locally produced rice versus imported rice; rate of mechanization along the rice value chain; cropping intensity in irrigated areas • Action sites: increased resource-use efficiencies during production at farm level; improved postproduction efficiencies that reduce losses and add value at harvest, drying, milling, processing, and storage for value-chain actors; adoption rates of new rice varieties with enhanced value (aroma, improved appearance, reduced chalkiness, appreciated texture, etc.); adoption rates of improved production and postproduction practices; # of successful contractual arrangements along a rice value chain
4. Increased sustainability and reduced environmental footprint of rice production	8. Environment—minimized adverse environmental effects of increased production intensification 11. Climate—increased carbon sequestration and reduction of greenhouse gases through improved agriculture and natural resource	• Global: through WLE collaboration • National: through WLE collaboration • Action sites: increased resource-use efficiencies during production at farm level; reduced emission of greenhouse gases, pesticide residues, water and air pollution; adoption rates of improved practices

	management	
5. Increased health and nutrition from rice and from diversification	3. Nutrition—improved diet quality of nutritionally vulnerable populations, especially women and children	• Global: through A4HN collaboration (will, among others, include measure of Disability Adjusted Life Years (DALYs) lost from micronutrient deficiency) • National: through A4HN as above; indicators to track delivery/use of products: # of GRiSP varieties released with increased nutritional content (provitamin A, Zn, Fe) and with reduced glycemic index • Action sites: to be decided (include crop diversification)
6. Increased capacity, gender equity, and resilience in the rice sector	5. Gender and empowerment—increased control over resources and participation in decision-making by women and other marginalized groups 6. Capacity to Innovate—increased capacity for innovation within low-income and vulnerable rural communities, allowing them to improve livelihoods 7. Adaptive capacity—increased capacity in low-income communities to adapt to environmental and economic variability, shocks, and longer-term changes 10. Future options—greater resilience of agricultural/forest/water-based/mixed crop-livestock/aquatic systems for enhanced ecosystem services	• Global: capacity built (# of scholars, # of trained advisors); # of technologies with explicit gender focus • National: # of GRiSP stress-tolerant varieties released; # of approved technologies; strengthened advisory systems (# of trained extension agents); # of policy briefs used to guide investments • Action sites: # of seed systems/producing groups, farmer groups, women's groups, learning alliances, contractual arrangements along value chains; gender equity and empowerment index; youth employment; # of machinery fabricated locally; # of videos, radio scripts, local extension materials

9.2 Table 2. GRiSP's global IDO targets in 2020 and 2035

Target 2020	**IDO**
Increase in global rice production with 85 million tons of paddy over 2010 values. [b]	1
40 million undernourished people reach caloric sufficiency in Asia, reducing hunger in the region by 7%. [b]	2
Expenditures on rice by those under the $1.25 (PPP) poverty line declined by nearly PPP $5 billion annually, resulting in 72 million people lifted above the $1.25 poverty line and the global number of poor reduced by 5%. [b]	2
Additional annual (over 2010 baseline) income benefit to rice farmers of $1.09 billion; additional total benefit to producers and consumers of $1.8 billion annually in SSA. [c]	2
4.2 million poor rice farmers and 6.8 million poor urban and rural rice consumers lifted above $1.25 poverty line, in SSA. [c]	2
Water, nitrogen, and labor efficiencies in rice systems improved on a wide scale, saving 7 billion cubic meters of irrigation water (at field level) annually. [b]	3, 4
Approximately 275 million tons of CO_2-equivalent emissions averted globally. [b]	4
Disability Adjusted Life Years (DALYs) lost from micronutrient deficiency decreased by 139,000 (7% reduced burden compared with 2004) through provitamin A rice and by 12,000 (1% reduced burden compared with 2004) through high-zinc rice, in 12 target countries in Asia. [d]	5
A new generation of 1,000 rice professionals (50%/50% graduate/postgraduate), at least 30% of them women, will have been trained between 2010 and 2020 to be capable of leading the development of the world's rice sector. [b]	6
Target 2035	**IDO**
Increase in global rice production with 170 million tons of paddy over 2010 values. [b]	1
Total increases in Asian rice production of 6.4–10%, over 2010 levels, due to 63 GRiSP technologies analyzed. [a]	1
Global average rice yield will reach 6 t/ha (paddy). [b]	1,2
62 million undernourished people could reach caloric sufficiency in Asia, reducing hunger in the region by 12%. [b]	2
Expenditures on rice by those under the $1.25 (PPP) poverty line would decline by PPP $11 billion annually (holding consumption constant), resulting in 150 million people lifted above the $1.25 poverty line and the global number of poor reduced by 11%. [b]	2
Input efficiencies will have grown by at least 30% in key high-input rice-growing areas, annually saving at least 4 million tons of nitrogen fertilizer and 30 billion cubic meters of irrigation water (at the field level). [b]	3, 4
Nearly 1 billion tons of CO_2-equivalent emissions will be averted globally. [b]	4
More than a million hectares of natural forests saved from clearance (compared with 2010 baseline level) because of increased productivity (leading to reduced forest clearance). [b]	4
Disability Adjusted Life Years (DALYs) lost from micronutrient deficiency decreased by 1,885,000 (92% reduced burden compared with 2004) through provitamin A rice and by 237,000 (12% reduced burden compared with 2004) through high-zinc rice, in 12 target countries in Asia. [d]	5
A new generation of 2,500 rice professionals (50%/50% graduate/postgraduate), at least 30% of them women, will have been trained between 2010 and 2035 to be capable of leading the development of the world's rice sector. [b]	6

[a]: SAT analysis, IRRI, unpublished data.
[b]: GRiSP original document, p 24-25, and p 180-184 for details on economic analyses.
[c]: Boosting Africa's Rice Sector, AfricaRice.
[d]: Alex Stein and Zeny Huelgas, unpublished data 2014.

9.3 Table 3. GRiSP's Products and services in 2016.

Flagship Project 1	Flagship Project 2	Flagship Project 3	Flagship Project 4	Flagship Project 5
Genetic Diversity Platform (300 genomes) Whole-genome sequence information for >200 genotypes and pipeline for SNP marker development New International Rice Informatics Consortium Genome editing tools to engineer multiple genes at target sites Phenotypic platforms using remote sensing images and near infrared reflectance for high-throughput evaluation of agronomic traits A package of essential traits for direct-seeded rice combined in a gene pool for deployment New genes or QTLs for low light tolerance, bacterial panicle blight resistance, and yield-related traits under direct seeding	New generation of rice hybrids with high yield and high seed production First varieties released that combine tolerance of drought and flooding First combined drought- + flood-tolerant rice varieties released High-yielding and premium-grain-quality rice varieties released with combined tolerance of salinity and submergence New candidate irrigated lowland varieties and with superior yield and specific value-added traits (Sub1, superior quality, specific disease and insect resistance genes) developed for Asia and Africa New generation of rice hybrids with elevated yield and high F_1 seed production rate released, in Asia and LAC Breeding lines with higher yield potential developed through pyramiding novel yield-enhancing genes Novel genes from wild rice species conferring high tolerance of soil salinity, and expressing C_4-like traits introgressed into indica breeding	Decision support tools to guide local crop and postharvest management available through mobile services (Crop Manager, RiceAdvice) RiceAdvice becomes a public good and is ready for upscaling in at least five African countries Effectiveness of RiceAdvice under water-intensified lowland (with incomplete irrigation systems) validated in Benin and Togo First version of the Good Agricultural Practices (GAP) basket adopted in at least 15 African countries Crop growth simulation models ready to be incorporated into decision support tools for rice cultivation Guidelines for climate-informed, resource-conserving management Crop management strategies adaptive to climate change and variability Early warning system on onset and "wetness" of monsoons, and adaptation recommendations for rainfed rice tested in Asia Farm-level decision tools to close yield gaps while reducing the environmental footprint	Real-time rice monitoring tool (area, yield, cropping calendar) for Asia Automated system for tracking outcome indicators and detailed household performance measures Extensive open-access global rice statistics and rice household information databases Gender disaggregation of all collected household data (including consumers and producers), allowing gender-specific analysis of producer and consumer preferences, adoption of new technologies, and the outcomes thereof Adoption and impact analyses disaggregated into gender and socially disadvantaged groups Set of contractual arrangements validated	A common ICT platform that provides one-stop information on rice and its management for extension agents and advisors (including a repository for multiple extension products) A competency-based training program for professional extension agents (public, private) Demonstrated model for large-scale engagement with women in dissemination and adoption of new rice technologies (products and services) Ricecheck as engagement approach with farmers to improve productivity Improved seed distribution systems for new and improved varieties Network of agricultural machinery manufacturers (Africa-wide Mechanization Task Force) fully operational in Africa (leading to more focused capacity-building efforts and rapid outscaling

Combined multiple anaerobic germination genes for flood-prone environments Combined multiple genes for resistance to two tungro viruses (RTSV, RBSV) Combined multiple genes for RHBV and blast diseases in single genotypes SNP markers for varietal identification and diversity analysis for LAC varieties—diversity chip	lines Demonstrated the high-throughput rapid generation advance (RGA) systems at key GRiSP breeding stations for routine use by breeding programs and trait development teams A new breeding information management system for large breeding programs released Customized SNP chips applied in breeding programs First varieties resistant to RYMV developed by MAS released in Africa First varieties with submergence tolerance developed by MAS released in Africa First varieties resistant to cold and blast released in Africa First Africa-produced hybrid rice varieties released in Senegal and Nigeria Core collection of new nutrition and quality traits for breeding Novel germplasm with elevated protein content and low glycemic index Molecular markers to screen healthy and nutritious attributes	Decision tools to raise productivity through improved crop management in drought-, flood-, and saline-prone environments Drought and cold stress maps for Africa; distribution maps with economic loss estimates of the weeds *Striga* and *Rhamphicarpa* in rainfed rice in ESA ESCAP: Ecosystem Services and Conservation Agriculture Platform established in Madagascar Ecologically based pest management (insects, weeds, rodents) that enhance system resilience to pests Soil and water management practices that reduce greenhouse gas emissions from rice fields Improved water-use efficiency of rice through dry direct seeding Integrated water management practices in polders of major river deltas in Asia that optimize multiple water use Commercialized improved technologies for farm-level drying (Solar Bubble Dryer), storage (hermetic systems), threshing, harvesting, milling, and parboiling Commercialized appropriate technologies that add value to lower-grade rice (fortified with minerals and vitamins; pasta products) locally available	among rice value-chain actors in Africa	of agricultural machinery) Multistakeholder platforms for rice value-chain development operational in at least four countries in Africa The Rice*e*Hub (www.ricehub.org) fully operational capturing "stories from the field" in the Rice Sector Development Hubs in Africa and storing scalable technologies following standard GRiSP format Five-year road maps for Rice Sector Development Hubs available based on discussions with development partners from public and private sector detailing desirable outcomes, indicators and target values, and R&D efforts needed to achieve these outcomes Assistance provided toward the operationalization of National Rice Development Strategies in at least four sub-Saharan countries Formulated rice sector development strategies and targets for Asian countries

	New phenotyping tools (metabolomics) for defining healthy attributes At least three value-added products commercially available through collaboration with local food processors in four African countries	Three new nutritionally enhanced rice-based products commercialized in collaboration with local food processors in eight African countries Documented approaches for piloting and outscaling of postharvest technologies through multistakeholder platform engagement with public- and private-sector actors along the rice value chain Technology options and business models for use of rice by-products husk and straw (e.g., energy generation, mushroom cultivation) Postharvest practices for reduced mycotoxin contamination of milled rice (a commercially available product of calcium oxide powder made from burned scallop shells)		

10 Annex 3. Results framework

In our results framework, we identify targets and track progress of both *output indicators*, which track progress in product development, and *outcome indicators*, which track progress in dissemination and outcomes of adoption of the products. As we follow a pipeline approach to product development (scientific discovery, innovation, prototype, final product), some products are in proof-of-concept stage and others in prototype and final product stage. Output targets are set for each product, but, since research outputs are by nature not very predictable, these targets are "*aspirational*" in character. *Output indicators* are tracked through annual milestones and through indicators that gauge the efficiency of product development, such as genetic gain in variety development. Many of our output indicators will be collected at research action sites.

Outcome indicators are tracked at three levels: (development) action sites, national, and global. At action sites, we distinguish between indicators that track outcomes as a consequence of the adoption of GRiSP's products and services by end users and outcomes as a consequence of adoption by intermediate users. Examples of "end-user outcome indicators" are the adoption rates of varieties and technologies, local yield and yield gaps, profitability of rice growing, local women's empowerment index, locally realized resource-use efficiencies, etc. Examples of "intermediate-user outcome indicators" are the number of demonstrations of products such as new varieties and technologies, tons of seed produced of GRiSP-derived varieties by public and private partners, the number of training events by partners and their participants, the number of local dissemination materials developed (such as videos, brochures) and used by partners, the number of locally adapted technologies (such as locally produced machinery), and the number of innovation systems, learning alliances, and value chains. *Aspirational targets* are determined through interactive processes involving GRiSP and local partners.

At the national level, we also distinguish two sets of indicators:

1. Indicators for benchmarking specific GRiSP outcomes at their action sites within countries. These indicators are the result of national adoption by end users of improved rice technologies and services that are partly, but not exclusively, derived from GRiSP. Indicators are collected primarily through (inter-)national statistics, supplemented by the use of tools such as modeling, GIS, and remote sensing. Periodic adoption studies will reveal adoption rates and impacts of GRiSP products at the national level beyond their action sites (for example, studies on the spread of varieties with GRiSP-derived ancestry). Example indicators are yield, yield gap, area, production, and import and export volumes.
2. Indicators that track the delivery/use of GRiSP's products and services to/by intermediate users beyond the action sites. The use of "preproducts" to develop locally adapted "end products" is also included. Example indicators are varietal

adoption/diffusion, capacity built (e.g., # of scholars), # of nationally released GRiSP varieties, # of seed lots requested by and shared with partners, the use of GRiSP prebreeding lines/parental lines by national partners, # of nationally-approved technologies for dissemination, tons of seed produced of GRiSP-derived varieties by public and private partners, and # of national policy documents and rice strategies.

At the national level, a*spirational targets* are set by national government policies and rice development strategies. Like at the global level, some IDO indicators and their targets will be obtained through collaborating CRPs.

At the global level, there are two sets of indicators:

1. One set provides an overall reference and is used for communicating the global ambitions of GRiSP. These indicators are the result of global adoption by end users of improved rice technologies and services that are partly, but not exclusively, derived from GRiSP. Indicators are obtained by aggregation of international or national statistics, supplemented by the use of tools such as modeling (e.g., global rice supply-demand models), GIS, and remote sensing.
2. The second set tracks the delivery/use of GRiSP's products and services to/by intermediate users globally (i.e., beyond the national level and action sites). These indicators directly track GRiSP's specific *contribution* to the above global outcome indicators, and complement *attribution* evidence derived from impact studies. Examples are (general) capacity built (e.g., number of scholars) and the global use of GRiSP products (e.g., number of globally shared seed lots, accessed information, and databases).

The indicators are mostly aggregated from national-level data (see above). *Aspirational targets* are derived from ex ante impact assessment studies by GRiSP and global supply-demand modeling (see Table 2 and Annex 1, Fig. 2). Some IDO indicators and their targets at the global level will be obtained through collaborating CRPs, such as A4HN for IDO 5, Nutritious and safe rice, and WLE for IDO 4, Increased sustainability and reduced environmental footprint.

Using this framework, we will continue to strengthen our *management for results* through the institutes that participate in GRiSP. Within the GRiSP institutes, achievements are already discussed with staff during annual performance appraisals, and we aim to strengthen this by making use of the new indicators of progress (both output and outcome indicators). Results will be discussed concerning product development (including upstream research), product delivery, and the enabling environment (specifically including capacity building and gender). Institutional systems for staff rewards will be linked to the achievement of GRiSP results when staff contribute significantly to the program. During annual GRiSP planning meetings, overall progress is discussed and resource allocations to Result and/or Product teams of Flagship Projects adjusted within existing operational flexibility. The same process takes place within specific bilateral projects that are part of GRiSP throughout the year. GRiSP partners are an explicit part of these processes. As products move along the pipeline from upstream research to delivery, the type and choice of partners are adjusted (see

here for an example on development and delivery partners for submergence-tolerant varieties).

11 Annex 4. Acronyms and abbreviations

A4HN	CGIAR Research Program on Agriculture for Nutrition and Health
ADB	Asian Development Bank
AfricaRice	Africa Rice Center
AfDB	African Development Bank
AMAF	ASEAN Ministers on Agriculture and Forestry
APAARI	Asia-Pacific Association of Agricultural Research Institutions
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ASEAN	Association of Southeast Asian Nations
CAADP	Comprehensive Africa Agriculture Development Program
CARD	Coalition for African Rice Development
CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
CIAT	International Center for Tropical Agriculture
CGIAR	CGIAR is a global research partnership for a food-secure future.
Cirad	Centre de coopération internationale en recherche agronomique pour le développement (French Agricultural Research Centre for International Development)
CORAF	Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricoles (West and Central African Council for Agricultural Research and Development)
CORRA	Council for Partnership on Rice Research in Asia
CRP	CGIAR Research Program
CSISA	Cereal Systems Initiative for South Asia
CURE	Consortium for Unfavorable Rice Environments
ECOWAS	Economic Community of West African States
FARA	Forum for Agricultural Research in Africa
FLAR	Latin American Fund for Irrigated Rice
FORAGRO	Foro de las Américas para la Investigación y Desarrollo Tecnológico Agropecuaro (Forum of the Americas for Agricultural Research and Technology Development)
GRiSP	Global Rice Science Partnership
IFAD	International Fund for Agricultural Development
INGER	International Network for Genetic Evaluation of Rice
IRD	Institut de recherche pour le développement (French research institute for development)
IRRC	Irrigated Rice Research Consortium
IRRI	International Rice Research Institute

JIRCAS	Japan International Research Center for Agricultural Sciences
LAC	Latin America and the Caribbean
NARES	national agricultural research and extension systems
NEC	National Experts Committee (24 AfricaRice member countries)
NEPAD	New Partnership for Africa's Development
PIM	CGIAR Research Program on Policies, Institutions, and Markets
PPMT	(GRiSP's) Program Planning and Management Team
QTL	quantitative trait loci
SAARC	South Asian Association for Regional Cooperation
SKEP	Scientific Knowledge and Exchange Program
SNP	single nucleotide polymorphism
SRP	Sustainable Rice Platform
STRASA	Stress-Tolerant Rice for Africa and South Asia