AGRICULTURE GLOBAL PRACTICE
DISCUSSION PAPER 11

A PORTFOLIO REVIEW OF WORLD BANK RICE PROJECTS: FISCAL YEARS 1984–2011

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Cover photos:

Top Left: Harvesting rice-fields in a White Thai village in Mai Chau, Hoa Binh province, northern Vietnam. Photo: © Tran Thi Hoa/World Bank.
Top Right: Landscape of fields and homes. Indonesia. Photo: © Curt Carnemark/World Bank.
Bottom: Harvesting irrigated fields. Indonesia. Photo: © Curt Carnemark/World Bank.

CONTENTS

TABLES

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ACRONYMS AND ABBREVIATIONS

1M+5R	1 Must and 5 Reductions
ADJ	Adjustment Loans
AFR	Africa (World Bank regional vice presidency)
APL	Adaptable Program Loans
ARD SB	Agriculture and Rural Development Sector Board
AWD	Alternate Wetting and Drying
CGIAR	Consultative Group on International Agricultural Research
DPL	Development Policy Lending
EAP	East Asia and Pacific (World Bank regional vice presidency)
ECA	Europe and Central Asia (World Bank regional vice presidency)
ERL	Emergency Recovery Lending
ERR	Economic rate of return
FAO	Food and Agriculture Organization (U.N.)
FY	Fiscal year
GHG	Greenhouse gas
GP	Global Practice
ha	Hectare
HYV	High yielding variety
IBRD	International Bank for Reconstruction and Development
ICM	Integrated Crop Management
ICR	Implementation completion report
IDA	International Development Association
IEG	Independent Evaluation Group
IPM	Integrated pest management
IRRI	International Rice Research Institute
LAC	Latin America and the Caribbean (World Bank regional vice presidency)
LIL	Learning and Innovation Loans
MNA	Middle East and North Africa (World Bank regional vice presidency)
MOA	Ministry of Agriculture
N	Nitrogen
NAMA	Nationally Appropriate Mitigation Actions
NRM	Natural resource management
PES	Payment for environmental services
SAR	South Asia (World Bank regional vice presidency)
SIL	Specific Investment Load
SIM	Sector Investment and Maintenance Loans
SRI	System of Rice Intensification
SSIA	Sustainable System of Irrigated Agriculture
t	Ton
TA	Technical Assistance Loans
VnSAT	Vietnam Sustainable Agriculture Transformation project

All dollar amounts are U.S. dollars unless otherwise indicated.

EXECUTIVE SUMMARY

Rice is the world's most heavily consumed staple crop. Its production requires enormous volumes of water and emits large quantities of atmospheric methane, a greenhouse gas some many times more powerful than carbon dioxide—particularly during a medium term period of about seven years. In a global context of growing population, increasingly scarce water resources, and climate change, more productive, sustainable, and efficient rice production warrants clear priority. The incidence of droughts associated with climate change is projected to increase in rain-fed rice-growing areas, and may very well extend further into water-scarce irrigated areas. A variety of climate-smart practices and technologies are available that can move rice production toward a triple-win scenario that entails increased productivity, enhanced resilience, and improved greenhouse gas mitigation. These generally entail some combination of lower inputs of water, inorganic fertilizer, and pesticides; improved soil and water management; and the controlled use of organic fertilizers—all while increasing yields. Adapted specifically to local conditions, this *agro-ecological intensification* carries a number of names, including the System of Rice Intensification (SRI), the "1 Must and 5 Reductions" (1M+5R), Integrated Crop Management (ICM) in rice cultivation, and the Sustainable System of Irrigated Agriculture (SSIA), among others.

Although this review of World Bank projects does not limit itself to those that incorporate these labels, it does focus on the application of sustainable principles in rice production in 172 Bank projects that were approved between 1984 and 2011. These had a total lending volume of $10.9 billion. Their development outcomes are gauged based on the projects' implementation completion reports, which also document lessons learned and results in greater detail.

The projects are grouped into *dedicated rice projects*, in which rice was the main focus of the intervention, and *nondedicated rice projects*, in which rice-related activities were not the primary concentration. Thirty-seven (22 percent) of the 172 projects were dedicated rice projects, and the remaining 135 were classified as nondedicated. The Africa Region had the largest number of rice-related projects with 78, followed by 42 in East Asia and the Pacific, and 29 in South Asia. Rice projects in East Asia and the Pacific had the largest proportion of lending at 37 percent. Madagascar had the largest number of rice projects with five, the latest of which was approved in 1997. Overall, the outcomes of these interventions were positive in terms of higher yields and incomes. Water control issues often emerged during earlier phases of the projects, but most appear to have been resolved in subsequent phases.

A number of crop production and soil management principles are essential for sustainable rice production. These include intermittent irrigation, reduced seed rate, early transplanting, wider spacing of seedlings, and applications of organic fertilizer. The effects on producers' income come about as a result of savings achieved through the lower costs associated with reduced seed, fertilizer, pesticide, and water inputs as well as through higher yields. This dynamic of producing more with less relies heavily on adaptation of the practices to suit the specific conditions in which they are applied. Production techniques that apply crop residues in lieu of nitrogen fertilizers can reduce levels of both methane and nitrous oxide emissions from rice fields compared with regular irrigated production. Increased rice grain and straw yield, root biomass, and soil organic matter, in part through applications of green manure and mulch, generate climate change mitigation benefits in which rice production sequesters substantially more carbon. Adaptation benefits are generated by producing more climate-resilient and disease-resistant plants.

Two issues emerged as being particularly critical to success:

1. Anticipating the demand for labor, particularly during the initial two years, when the practices involved in introducing new organic fertilizer and the amount of time required for weeding both increase the need for labor
2. Controlling the use of irrigation water, as the new practices entail using less water but applying it at more frequent intervals

Among the projects that did not entail any principles of sustainable production, improvements to infrastructure were the most prevalent type of intervention, often in combination with improved variety and fertilizer packages and new policies. Nineteen of the projects reviewed introduced some principle of sustainable production. The most common sustainable rice production intervention is the use of organic fertilizer and nonchemical pest management. Other interventions such as alternate wetting and drying, early single seeding, and transplanting were introduced in relatively few projects. The experience of the projects that incorporated sustainable rice intensification points to the importance of a number of issues, including the following:

- How farmers control the water supply is the key to sustainable water management systems, and all other sustainable rice production practices are predicated on it.
- There is a need for ministry of agriculture or other government support in scaling up sustainable practices through demonstrations, field days, and public endorsements, as well as the need to avoid sending producers conflicting messages about subjects such as fertilizer and pesticide use.
- The knowledge intensiveness of sustainable rice intensification practices increases the need to upgrade farmers' skills through training and extension. Building the capacity of advisory services and farmer organizations should take place early on during implementation, when projects are well advised to avoid overfocusing on technical changes. In many contexts, farmer field schools were recognized as potentially effective means for reaching farmers, though questions about their cost effectiveness were raised as well.
- The effects of introducing sustainable rice production on the demand for labor warrant careful upfront attention. The availability and cost of labor need to be weighed against the income effects of reduced costs for other inputs and higher yields. Again, the time required for weeding and applying organic fertilizers is likely to increase at certain times. In the very large number of cases in which this consists mainly of female labor, this carries gender-related implications that need to be carefully monitored.

Climate change adaptation and mitigation benefits were mentioned in the implementation completion reports of 10 projects, and most of these related to alternative practices to slash-and-burn agriculture. Actual reductions in greenhouse gas emissions that were attributed to improved rice production were mentioned in two projects, one in Indonesia and one in Vietnam.

The yield results reported by the rice projects varied significantly. The average yield achieved in irrigated systems was almost twice as high as in rain-fed systems. Average yield increases over the course of a project were also more moderate in rain-fed systems, with 0.7 tons per hectare versus 1 ton in irrigated systems. Interpreting the correlation of the yield responses to the types of interventions, and especially to the sustainable rice-growing practices presents a mixed picture. Substantial yield increases can be achieved through improvements to irrigation infrastructure without sustainable rice intensification. The introduction of salt-resistant varieties and irrigation improvements in Senegal, for example, increased yield from an already fairly high 4.5 tons per hectare to 5.9 tons (Project Number P002343, 1988). No principles of sustainable production appear to have been applied in that project. In an irrigated system in Tanzania, yields increased from a moderate 1.1 tons per hectare to 1.7 tons with the application of several sustainable rice-growing practices (Project Number P067103, 2003). In Madagascar, different combinations of sustainable practices and improved rice varieties, although improving the extension service, led to yield increases between 43 and 188 percent in five projects between 1989 and 1997.

All of the implementation completion reports that made reference to gender issues and the role of women in rice systems described projects in the Africa Region. In Mali, Côte d'Ivoire, Madagascar, Mauretania, and Guinea Bissau, rice was referred to as a woman's crop. Projects in Madagascar, Mauritania, and Côte d'Ivoire reacted to this by targeting female farmers, in part by increasing the number of female extension agents. In Madagascar, 50 percent of newly appointed extension agents were women and they quickly became involved in the wetting and drying demonstration plots in farmers' fields. In Mali, crop diversification encouraging farmers to rely proportionately less on cotton and more on rice similarly emphasized women farmers. In Guinea Bissau, banning slash-and-burn practices removed farmers from highland rice production, and this affected women farmers in particular.

The overall *Outcome* rating for the group of 19 projects with sustainability-related components was quite favorable. Two-thirds received a *Likely* rating. A lower share of these projects received favorable *Sustainability* and *Institutional Development* ratings. Because most of the projects involved a variety of interventions and focused on more than one crop, it cannot be determined what role the sustainable practices they introduced played in their generally favorable rating.

The economic rate of return (ERR) to investments was calculated and reported by 72 of the projects. The value of the ERR ranged between 3 and 100 percent. The average ERR for projects in the Agriculture Global Practice is 34 percent—compared with 22 percent for all Bank projects. The average ERR of the 72 rice-related projects is 25 percent. No correlation or differences could be found between the ERR and the type of intervention, region, or age of the projects. However, among these 72 projects were two operations that had explicitly followed SRI principles, and their ERRs were calculated as 44 and 47 percent.

Because sustainable rice production practices are generally scalable, and farmers can experiment with them on small plots of their land before introducing them more broadly, the practices effectively limit overall risk. And because some sustainable practices are already in place in many areas, project planning may begin by looking for these existing practices and the producers who are already experimenting with or using them. These can become effective partners in adapting new practices to local conditions and scaling them up. Many projects included the introduction of new varieties, without exploring the potential additional yield effect of also introducing rice intensification practices—a missed opportunity to increase not only yield and incomes, but also climate cobenefits.

A PORTFOLIO REVIEW OF WORLD BANK RICE PROJECTS: FISCAL YEARS 1984–2011

BACKGROUND AND SCOPE OF WORK

Rice, wheat, and maize together supply more than 50 percent of all plant-derived calories consumed by the world's population. Of these three, rice is by far the most important food crop for people in low- and lower-middle-income countries. Asia produces and consumes about 90 percent of the world's rice. But rice is also a staple food in Latin America and the Caribbean, and over the past 30 years demand for rice in West Africa has grown at an annual rate of 6 percent, replacing traditional cereals (Mohanty 2013).

The intensity and frequency of droughts are projected to increase with the effects of climate change, particularly in rain-fed areas and very likely in water-scarce irrigated areas as well. By 2050, rice yields may experience losses of between 10 and 15 percent, whereas rice commodity prices are likely to increase by a third. The production of rice emits large quantities of methane, in addition to consuming large amounts of water. More sustainable rice production can be achieved through better water, plant, soil, and nutrient management. Those practices that are instrumental in achieving a triple win in terms of productivity, resilience, and greenhouse gas mitigation are referred to here as being "climate smart." These represent a departure from conventional measures to intensify rice production in that climate-smart practices pursue higher yields with substantially lower inputs of seed, water, fertilizer, and pesticides. They also assign considerable preference to organic over inorganic fertilizers, purposefully using inputs such as crop residues and green manures as sources of rice crop nutrients.

METHODOLOGY

The report is based on a review of implementation completion reports (ICRs) of the 172 World Bank projects that included rice-related interventions that were approved between 1984 and 2011.[1] Implementation completion reports are the principal means

[1] In two cases the Implementation Completion Report Review had to be used because the ICR was unavailable.

of rating and documenting the outcomes of Bank projects in terms of how well the development objectives that were set out for the projects at their appraisal were achieved. ICRs also document more detailed results in terms of lessons learned and financial indicators such as economic rates of return. The major characteristics of the rice-related interventions and outcomes were coded and recorded using an Excel database and the data and findings are summarized herein.

CHARACTERISTICS OF THE COHORT OF PROJECTS

Among the cohort of projects reviewed, the relative share of lending toward specifically rice-related activities varied, making it useful to distinguish between dedicated and nondedicated rice projects. In dedicated rice projects, rice was the main crop or the main focus of the interventions. In nondedicated rice projects, rice-related interventions made up a relatively smaller portion of overall activities, and rice was often one of a number of other crops. The cohort consisted of 37 dedicated and 135 nondedicated rice projects.

The 1990s saw the largest number of rice-related projects, reflecting a push to keep pace with population and growth in demand, mainly in Asia, and mainly through higher yield varieties rather than area under cultivation (figure 1.1) (Calpe 2006). Fewer than half as many rice-related projects were approved the following decade, though the share of dedicated rice projects increased significantly after 2000, which may be related to the increase in commodity prices, particularly late in the decade. A number of dedicated Development Policy Lending (DPL) and Emergency Recovery Lending (ERL) projects focused on measures to mitigate rice price hikes beginning in 2007. Since 2011, there have been 38 new approvals of projects with rice-related content that are currently under implementation but outside the purview of this review.

Rice-related projects are spread across 53 countries in all six regions of the Bank. The total International Development Association (IDA)/International Bank for Reconstruction and Development (IBRD) lending volume of the rice portfolio is US$10.9 billion. The majority of dedicated and nondedicated projects are found in Africa (AFR) (*n* = 78), followed by East Asia and Pacific (EAP) (*n* = 42) and South Asia (SAR) (*n* = 29) (figure 1.2). A much higher share of the dedicated projects is found in AFR than in other regions, because of the large number of ERLs in the late 2000s focusing on rice and other staples during the food price crisis. Two-thirds of the projects in AFR were approved after fiscal 2000.

The country focus of the rice portfolio matches those countries with the largest rice production area and highest per capita consumption—India (13 projects), China (12), Indonesia (11), and Bangladesh (7). Countries such as Vietnam and the Philippines, also among the world's top 10 rice producers, had comparatively few rice projects (4 and 5, respectively), during the 27 years that were covered by the review. Several African countries (led by Madagascar with 8 projects, Mali with 6) saw more rice-related

FIGURE 1.1. NUMBER OF RICE-RELATED PROJECTS PER APPROVAL PERIOD

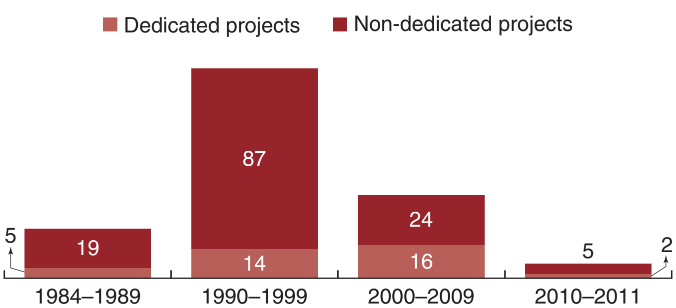
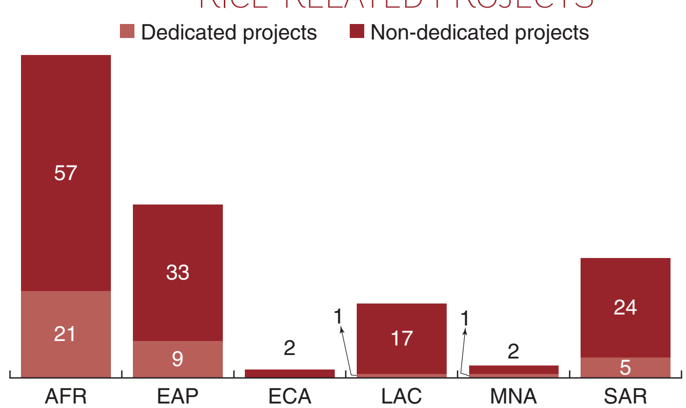


FIGURE 1.2. REGIONAL DISTRIBUTION OF RICE-RELATED PROJECTS



Note: ECA = Europe and Central Asia; MNA = Middle East and North Africa.

projects than Vietnam and the Philippines. The lending figures show that EAP is leading the regional distribution (37 percent of lending), followed by AFR and SAR (23 percent each), and Latin America and the Caribbean (LAC) (16 percent) (figure 1.3).

Nondedicated projects show a disproportionately high share of projects above $100 million and a relatively low share of small projects under $10 million (figure 1.4). The largest share of projects falls in the $20 to $50 million bracket. The average size of a dedicated rice project is $45 million; nondedicated projects are comparatively larger with an average lending volume of $69 million. Projects in EAP and in SAR have on average about three times the lending volume compared with projects in AFR.

The lending volume of the 37 dedicated projects amounts to $1.66 billion. Thirty of the 37 dedicated projects are under the Agriculture and Rural Development (ARD) Sector Board (many of the older projects have not been retrofitted to the new Global Practices yet, so the Sector Board categorization was kept here). Overall, 150 of the projects were under ARD SB. Specific Investment Loans (SILs) were the main lending instrument; also of note is the relatively large number of dedicated ERLs, helping rice-growing countries recover their main staple crop after natural disasters such as storms and counterbalancing world market price hikes (figure 1.5). The number of rice sector dedicated DPLs with objectives to improve import price policies and tariffs to protect the rice sector in those countries are also noteworthy.

Projects were classified into four categories, based on the type and focus of the rice-related interventions:

» Services (mainly improvements to the research and extension system through restructuring and capacity building, breeding and seed supply efforts, market information)
» Infrastructure (usually irrigation and drainage related; some grain market/storage infrastructure)
» Policies (price liberalization, tariffs and import policy, privatization)
» Natural resource management (NRM) (watershed development, resource conservation, marshland and sodic lands rehabilitation)

Many projects included a mix of components; in that case, the main component was used to define the category (figure 1.6). The services projects were the most numerous among both the nondedicated and the dedicated rice projects. Infrastructure projects formed the second largest group and almost all were nondedicated projects. Among the dedicated projects, rice policy interventions were the second most common. Less than 6 percent of rice projects had an NRM focus.

FIGURE 1.3. RICE PORTFOLIO LENDING AMOUNT (US$ MILLION) 1984–2011, BY REGION

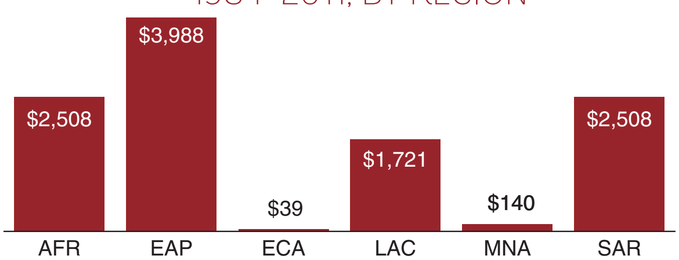


FIGURE 1.4. SIZE OF PROJECTS INCLUDED IN THE REVIEW

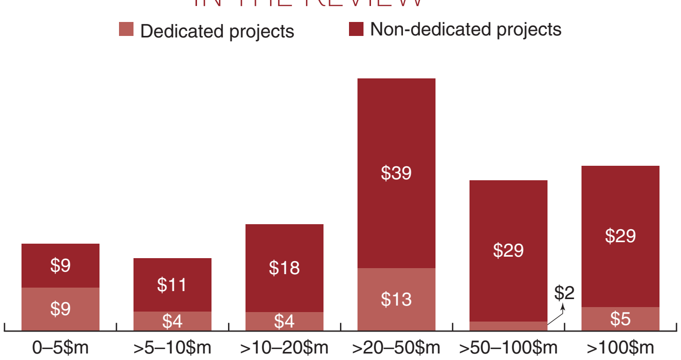


FIGURE 1.5. LENDING INSTRUMENTS USED IN THE PORTFOLIO

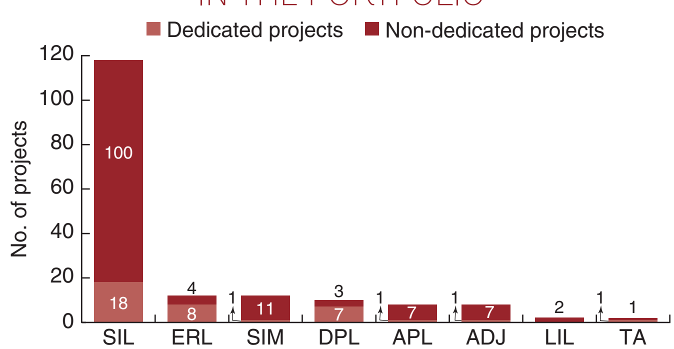


FIGURE 1.6. TYPES OF PROJECTS SORTED INTO FOUR BROAD CATEGORIES BASED ON MAIN INTERVENTIONS

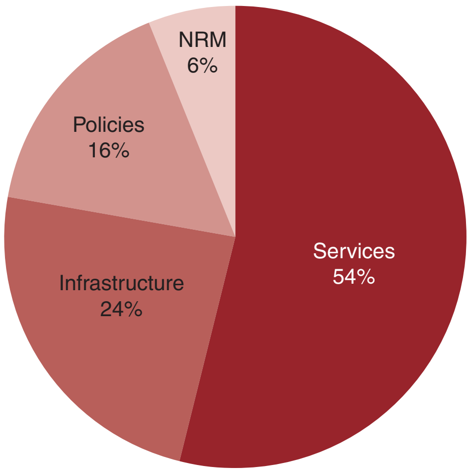
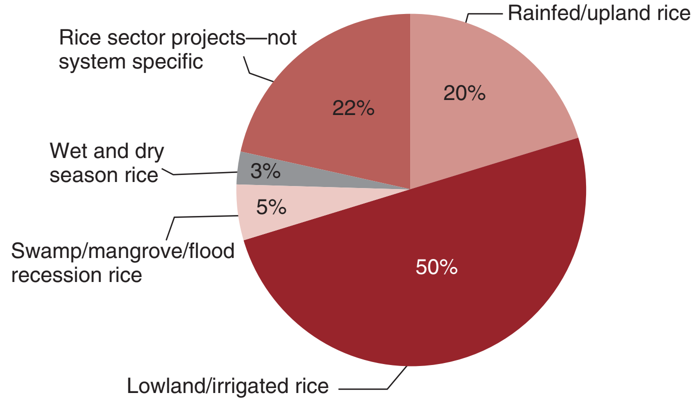


FIGURE 1.7. RICE SYSTEMS TARGETED BY THE PROJECTS



RICE FARMING SYSTEMS TARGETED BY THE PROJECTS

The main rice system targeted by just over half of all dedicated and nondedicated rice projects was lowland/irrigated rice, followed by sectorwide, not system-specific types of projects, and upland/rain-fed systems (figure 1.7). In 17 percent of cases, projects were implemented in several regions of a country targeting more than one rice farming system.

SUSTAINABLE RICE PRODUCTION PRINCIPLES PROMOTED IN THE PORTFOLIO

A number of crop production and soil management principles are generally considered essential for sustainable rice production. Some specific approaches and acronyms coined in different countries by governments and international agencies are referred to in the portfolio—they all include a core set of these principles (for example, SRI, ICM in Indonesia, SSIA in the Philippines, 1 Must and 5 Reductions in Vietnam—see appendix B for details and links to the sources). Other projects were found to describe good, regionally adapted sustainable agronomic practices without referring to a specific approach. According to Dr. Erika Styger from the Cornell-based SRI Network and Resource Center, "it does not matter what you call it, what matters is that the combination and adaptation of principles works in your context." The experiences reported by the advocates that have been applying variations of this approach all point to significant income effects through yield increases and savings from input reductions (reduced expenses for seed, fertilizer, pesticides, water)—doing more with less. The two potentially critical issues that need to be addressed to ensure the success of the approach are

1. anticipating the labor demand—sometimes it is reported to be higher, at least during the first two years, because of new organic fertilizer practices and additional labor demand for weeding, and
2. the importance of irrigation water control—less water is needed, but at more frequent intervals (WRI 2014).

Table 1.1 lists the most common practices and compares their inclusion in the different approaches—based on a review of the sources listed in appendix B. The practices are interrelated and have to be adapted to local conditions. Adaptation of the techniques are often undertaken to accommodate the local climate and soil conditions, labor availability, water sources and control, and access to organic inputs. There are additional practices that are optional and are not "ticked" for SRI because it first has to be determined whether the practice makes sense in the country and farming system context. The other approaches are specific to country contexts (SSIA in the Philippines, 1M+5R in Vietnam, ICM in Indonesia); therefore, they require additional practices based on the local experience.

TABLE 1.1. SUSTAINABLE RICE PRODUCTION PRACTICES—COMPARING THE APPROACHES

Management Practices	SRI	SSIA	1M+5R	ICM	Potential Risks
Core practices					
Intermittent irrigation/ AWD	x	x	x	x	The schedule of drying and wetting depends on local conditions; control over the water source, or good cooperation among irrigation users, is key.
Reduced seed rate/single seeding transplantation	x	x	x		Will be adopted if farmers are confident that water management is reliable and under their control.
Early transplanting	x	x		x	Avoids root competition and ensures strong plant establishment with multiple tillers and quick and early plant establishment.
Wider spacing of seedlings	x	x			Will be adopted if farmers are confident that water management is reliable and under their control. Also depends on tilling of the variety used. Spacing depends on soil quality. Encourages root and canopy growth.
Organic fertilizer application	x		x	x	Often this is traditionally practiced for other crops, but not usually for rice. Traditions have to be overcome.
Additional/optional practices					
Reduced N fertilizer application	x		x		If enough organic fertilizer is applied, then the application of N can be reduced.
Use of certified seeds/HYV			x	x	The principles have positive yield effects regardless whether local varieties or HYV are used. It depends on the characteristics of the varieties currently used if a change is beneficial (tilling, length of growth cycle).
IPM—reduced use of pesticides			x	x	Depending on the climate, cropping cycles, and predominant pest problems, this may be a priority.
Rotary weeding and mulching of weeds		x		x	When fields are not continuously irrigated, more weeds grow that need to be controlled; incorporating them into the soil acts like green manure, and aerates the soil. Mechanization is still a challenge—labor demand may be an issue.

Note: AWD = Alternate Wetting and Drying; HYV = high yielding variety; IPM = integrated pest management; N = nitrogen.

Especially in Asian countries, with long traditions of growing rice, changing farmers' practices (for example, applying organic fertilizer, lower seed rate, and wider spacing) is more challenging than perhaps it is in AFR.

Comparing project interventions with the list of practices in table 1.1 revealed that half of the 172 projects did not include any of the sustainable rice production practices (listed in tables 1.1 and 1.2). The main interventions promoted by these projects were infrastructure improvements, often combined with improved variety and fertilizer packages, as well as policy interventions. The share of dedicated projects was very similar in both groups (20 percent and 23 percent, respectively) (figure 1.8). The other half of the projects included at least one of the typical management practices that are considered core to sustainable rice

FIGURE 1.8. INCLUSION OF SUSTAINABLE RICE PRODUCTION PRACTICES

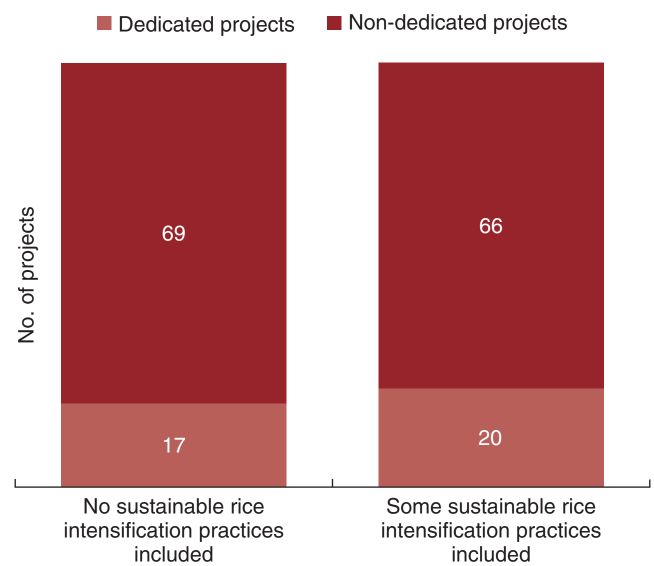


TABLE 1.2. SUSTAINABLE RICE PRODUCTION PRACTICES FOUND IN THE PORTFOLIO

Sustainable Rice Production Practices Introduced in the Portfolio *(more than one practice may have introduced)*	**No. of Nondedicated Projects Including the Practices**	**No. of Dedicated Projects Including the Practices**
– Increased use of organic fertilizer/soil fertility practices	44	16
– IPM and bio-pesticide use	22	8
– Soil amelioration practices	15	4
– Soil conservation measures including direct seeding and leveling	15	8
– Spacing and single seedling planting	5	5
– Earlier transplanting time of rice seedlings	2	3
– Intermittent water application instead of continuous flood irrigation	1	6
– Rotary weeding to control weeds and to promote soil aeration	2	2

production. Many projects did not have much of an in-depth agriculture technology dimension and were designed around infrastructure and irrigation, or the distribution of technology packages of seed and fertilizer. One could argue that there were a number of missed opportunities of not including a pilot of sustainable rice production principles in some of these projects—at least in the younger projects that were approved after 2007, when the evidence of the potential of the approach was being more widely published. However, it is important to be aware that there are many other ways that can be applied to improve production. Not having an agriculture technology dimension is not necessarily a problem: technology may not have been the limiting factor in the country context at the time of the project.

Table 1.2 lists the main sustainable rice production practices that were described in the portfolio, summarized into eight categories. The most commonly included intervention is the use of organic fertilizer and nonchemical pest management. The core principles of SRI such as alternate wetting and drying, early and single seeding transplanting, and spacing are introduced in very few projects. Eight projects specifically refer to the SRI, CMI, or SSIA approaches, from as early as 1995 (Madagascar Project Numbers P001537, P001563, P001522) to a project in Indonesia from 2010 (Project Number P120313). Sustainable rice production does not necessarily require the application of all principles in every project; the combination is location specific and requires an analysis of the local conditions. Although each one has a potential positive yield effect, experts of the different approaches agree that a combination of key elements (table 1.1) leads to greater success.

Promising project examples. There were 19 projects that combined one or more of the key sustainable rice production practices (as defined in table 1.2): reduced and controlled water application, reduced seed rate, wider spacing, early transplanting, and the use of organic fertilizer, or projects that specifically mentioned the System of Rice Intensification, even if the practices were not described in detail in the ICR (the 19 projects are listed in appendix C). More than half of these projects are in AFR (11), 5 in EAP and 3 in SAR. The yield increase of these 19 projects shows mixed results: it varied between 0 and 188 percent;[2] the average increase was 48 percent. The highest yield increases were achieved in the three projects in Madagascar, and in Rwanda, where the intensification principles were applied to several crops, including rice. These projects may not be good practice examples per se—they experimented with the approach, and a review of their lessons learned can help inform future efforts of task teams who consider investing in rice intensification practices:

- The importance of the support by the government/Ministry of Agriculture (MOA) for upscaling the approach (by supporting demonstrations and field days, public endorsement), and in avoiding conflicting messages to farmers (for example, on pesticide and fertilizer use).
- The knowledge intensiveness of the approach and the critical role of extension and training in spreading the approach and in skills upgrading

[2] India UP Sodic Lands (Project Number P009961 from 1993) saw no yield increase—the yield stabilizing effect in the Sodic Lands projects was seen as a positive because the decline in yields was halted.

among farmers have been identified by several projects. The need to program and build capacity for advisory services and support to farmer organizations and farmer training early in the program was recommended, instead of focusing only on the technical interventions. In this context, the role of Farmer Field School (FFS) as an effective extension tool in reaching farmers was recognized, although questions of its cost-effectiveness also were raised.

» The effect of introducing sustainable rice production principles on labor demand needs to be evaluated—organic fertilizer application and weeding may require more labor at certain times, labor availability and labor cost need to be weighed against the income effects through reduced costs for other inputs and higher yields. In particular, the effect on female labor needs to be carefully monitored.

» A sustainable water management system is key to the success of the other sustainable rice production practices; control of water supply by farmers is crucial.

The experience in Madagascar is probably the best documented of all countries in the ICRs—of the eight rice-related projects found in Madagascar five supported the SRI approach between 1990 and 1997. However, the description of these projects shows the potential for significant yield increases and income gains, but points to the need for controlled water management for the success of the SRI approach (see box 1.1).

Although the lessons included in the ICRs are an important source of learning for potential future operations in the same countries, the SRI-Rice network and resource

BOX 1.1. THE SRI EXPERIENCE IN MADAGASCAR

Madagascar, where the SRI approach was developed in the 1980s, saw five projects in the 1990s that included SRI principles. The yield results were significant, but the ICRs identified water management as a crucial factor. The following ICR excerpts document the experience. After 1997, the World Bank apparently no longer invested in SRI interventions in Madagascar. According to Erika Styger of SRI-RICE, the approach is very widespread in Madagascar today; the water management issue and initial labor demand implications have been overcome by careful local adaptations and were in the end not a main obstacle to the spreading of the SRI approach. http://sri.cals.cornell.edu/countries/madagascar/index.html.

In 1990, about 3,000 on-farm demonstration plots showed the potential of SRI to increase yields and incomes (Madagascar Extension Pilot Project Number P01521, 1990): "rice yields on some 1,700 demonstration plots in farmers' fields, with good water control, increased to nearly twice the yields on control plots using traditional techniques. On more than 1,350 separate demonstration plots, for early transplanting of seedlings (without improved water management), yields were 53 percent higher than on control plots. In both cases, these results were achieved without any cash investment, through use of techniques adopted directly by the farmers. The gross margins generated by application of these techniques amounted to an equivalent of approximately US$300 and $125 per hectare, respectively."

According to the Madagascar Extension Program, Project Number P01563 of 1995, "Instructional messages that were disseminated included . . . Intensive Rice Production System (SRI) technology, which is one of the most promising technologies for irrigated rice (it increases rice yields five-fold), was widely promoted. One drawback, though, is that SRI is very labor intensive and requires a strong and sustainable water management system, which was not a given in many cases. The most widely adopted technologies were new plant varieties; planting husbandry (early planting of seedlings at less than 25 days of age versus more than 60 days, in line versus random, lower number of seedling per hole); and integrated nutrient management, which focuses on an agro-biological approach." The project also noted that "extension agents are too old, uneducated and unmotivated."

According to Madagascar, 2nd Irrigation Rehabilitation, Project Number P01522, 1995), "experiments were conducted to demonstrate how to increase rice yields with the application of organic manure in rice fields. These demonstrations made clear that with simple tools . . . , lowland rice production increased to 11–14 tons per hectare, upland rice yield could increase by 600%, and variability of yields could decrease by 300%. The number of farmers adopting the recommended technology was very low because the new technology required more cash (up to 300% more) and more labor (around 35% more) as compared to more traditional practices."

"Some effective but knowledge-intensive technologies did not lend themselves well for spontaneous replication, e.g. intensive rice systems which require precise water management" (Madagascar, 1997, Project Number P01537).

center at Cornell has the most comprehensive collection of resources and experiences from all over the world, and can serve as a source of information on practices, conditions, and lessons learned, and can link to resource persons in many countries.[3] The e-learning tool developed by the World Bank also provides a how-to guide on the application of SRI practices for farmers and audio interviews with a number of stakeholders discussing their experience with the approach.[4]

Adoption rate of sustainable production principles. Two projects in Madagascar are the only projects found in the review to explicitly discuss the adoption rate of rice intensification principles. The Second Irrigation Rehabilitation project (Project Number P001522, from 1995) reports an adoption rate of 53 percent of SRI principles, and the National Ag Research project (Project Number P001546, from 1989) reports a 40 percent adoption rate for an early transplanting age.

Climate cobenefits and the potential for triple-win outcomes. Sustainable rice production practices that champion alternate wetting and drying production techniques use less water and lower amounts of nitrogen fertilizers, and incorporated crop residues create higher climate benefits than regular irrigated rice production by reducing the level of methane and nitrous oxide emissions from rice fields. Other mitigation benefits include increased carbon sinks through more rice grain and straw yield and root biomass, more soil organic matter, as well as green manure and mulch applications. Moreover, the sustainable production principles create adaptation benefits by producing more climate-resilient and disease-resistant plants. Increased productivity of water, seed, and labor contribute to higher returns per hectare and farm incomes. The World Bank lists these and other principles in its typology of climate adaptation and mitigation benefits, referring to specific crop production and irrigation and drainage practices, many of which are reflected in the sustainable rice production principles.[5] The climate adaptation and mitigation cobenefits of SRI are summarized in a flyer produced by SRI-RICE.[6] Climate cobenefits were rarely mentioned or quantified in the ICRs. It is expected that more recent projects will pay more explicit attention to these climate cobenefits because of the increased awareness and attention to these effects in recent years.

The Vietnam Ag. Competitiveness project (Project Number P108885) achieved greenhouse gas emissions reduction of up to 19 tons per hectare) (t/ha) (a 95 percent reduction compared with the control) and reduced water use by over 40 percent per ha through its application of sustainable rice intensification principles (World Bank 2014).[7] Vietnam's government is fully supporting the approach, closely involving its research and extension services in further adapting the "1 Must and 5 Reductions" principles. The Sustainable Agriculture Transformation Project will build on the pilot and expand the approach to other provinces.[8] This project was an exception in this

[3] For more information see the SRI Cornell website: http://sri.cals.cornell.edu/.

[4] You can find the tool here: http://info.worldbank.org/etools/docs/library/245848/.

[5] http://www.worldbank.org/content/dam/Worldbank/document/Typology.pdf.

[6] http://sri.ciifad.cornell.edu/conferences/IRC2014/booth/SRI_climate_smart_rice_production_%20handout_2014.pdf.

[7] See page 40: http://documents.worldbank.org/curated/en/2014/11/20467615/vietnam-agriculture-competitiveness-project. Several sources report on the success of the project and its principles:

IRRI Closing Rice Yield Gaps in Asia (CORIGAP) online article: http://corigap.irri.org/countries/vietnam/activities-in-vietnam/1-must-do-5-reductions;

World Bank blog: http://blogs.worldbank.org/voices/slogan-sustainable-agriculture-mot-phai-nam-giam-rice-production;

CGIAR, Research program on Climate Change Agriculture and Food Security: Putting alternate wetting and drying on the map globally and nationally; online publication: https://ccafs.cgiar.org/research/results/putting-alternate-wetting-and-drying-awd-map-globally-and-nationally-0#.VfKAdhGqqkp.

[8] Several sources report on the success of the project and its principles:

IRRI Closing Rice Yield Gaps in Asia (CORIGAP) online article: http://corigap.irri.org/countries/vietnam/activities-in-vietnam/1-must-do-5-reductions;

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https://www.google.com/?gws_rd=ssl#q=1M5R+vietnam;

http://corigap.irri.org/countries/vietnam/activities-in-vietnam/1-must-do-5-reductions;

http://blogs.worldbank.org/voices/slogan-sustainable-agriculture-mot-phai-nam-giam-rice-production;

https://ccafs.cgiar.org/research/results/putting-alternate-wetting-and-drying-awd-map-globally-and-nationally-0#.VfKAdhGqqkp.

review—there rarely was an explicit discussion of climate cobenefits of the rice production interventions in the ICRs—only 10 of the 172 reviewed ICRs (less than 6 percent) mentioned this aspect (table 1.3). The Indonesia Climate Change DPL included SRI production and Climate Field Schools in eight provinces—no further details on the component were included in the ICR. The most frequently mentioned climate benefit was reduced emissions from the reduction/elimination of slash-and-burn land-clearing practice associated with lowland irrigated areas.

TABLE 1.3. DISCUSSION OF CLIMATE COBENEFITS IN THE 172 ICRS REVIEWED

Discussion of Climate Cobenefits in the ICRs	Frequency of Contents
– Ecological control of methane emissions from irrigated rice	2
– Reduced water use in irrigation	1
– Reduced emissions from slash-and-burn practice	5
– Climate resilient agricultural practices*	2

*Both these projects promote SRI principles (Indonesia—Climate Change Development Policy Loan, P120313, FY2003; Vietnam Ag. Competitiveness project, P108885, FY2009).

The discussion of climate cobenefits of agricultural interventions has intensified in recent years, and since 2012 World Bank projects are expected to include the percentage of lending that will have climate adaptation or mitigation benefits. From 2012 until August 2015, another 38 projects were approved that contain rice-related interventions. Of these, 10 projects—more than a quarter—are expected to bring substantial climate cobenefits (mitigation or adaptation benefits) (table 1.4). It can be expected that the ICRs of these projects will describe and measure the climate cobenefits of sustainable rice production interventions in more detail than the cohort of projects reviewed for this report. An analysis of this cohort of 38 interventions currently under implementation is not part

TABLE 1.4. RICE PROJECTS WITH EXPECTED CLIMATE COBENEFITS CURRENTLY UNDER IMPLEMENTATION

FY	Region	Project ID	Name	Adaptation Cobenefits (US$, millions)	Mitigation Cobenefits (US$, millions)	IBRD/IDA Commit (US$, millions)
FY2014	AFR	P147514	Madagascar Emergency Food Security and Social Protection	5.5	3.3	52.0
FY2014	AFR	P125024	Gambia Commercial Agriculture and Value Chain Management	9.8	0.0	13.9
FY2013	AFR	P094183	AFCC2/RI Ag Productivity Program	9.2	5.1	73.8
FY2013	EAP	P117243	Indonesia Sustain Management of Ag Res and Technology	1.3	12.2	64.0
FY2015	EAP	P147629	Myanmar Agricultural Development Support	50.0	18.9	90.0
FY2015	EAP	P145055	Vietnam Sustainable Agriculture Transformation	2.5	87.4	171.4
FY2014	EAP	P130014	Vietnam Irrigated Ag Improvement	165.9	19.2	174.6
FY2014	EAP	P125496	China Integrated Modern Ag Dev	179.0	11.5	192.0
FY2014	LAC	P131013	Peru National Agricultural Innovation	12.8	0.0	38.8
FY2014	SAR	P120583	Bangladesh Modern Food Storage Facilities	81.9	0.0	81.9

Note: FY = fiscal year.

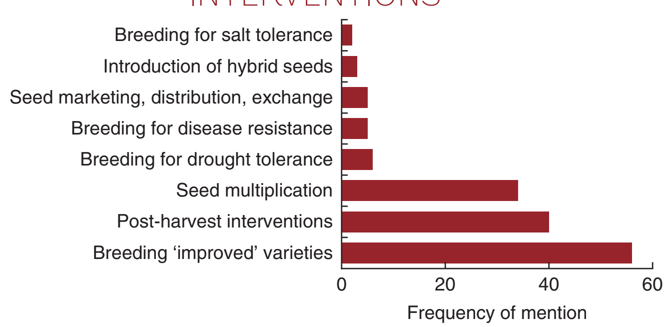
of this review because no completion reports are currently available.

OTHER RICE-RELATED PROJECT INTERVENTIONS: INPUT USE

Rice varieties and seed. Rice seed and variety related interventions were included in 83 projects. The single most frequently included intervention was the breeding and the introduction of high-yielding or otherwise improved rice varieties; such activities are described in 56 projects (figure 1.9). Forty projects included postharvest rice interventions such as milling, threshing, seed storage, drying, and shelling. Often the variety interventions come in combination with one or more of the aforementioned sustainable rice production interventions; however, in 18 projects variety improvement or introduction was the only rice-related intervention. Very few specific breeding efforts for drought, salt, or disease resistance were described—most of these were found in SAR. Also, seed multiplication through specialized farmers and on research stations was a major focus—especially in EAP and in AFR and promoted by 34 projects. Hybrid varieties were introduced in Vietnam, India, and the Philippines.

Inorganic fertilizer use. About a quarter of the projects ($n = 45$) provided some information on fertilizer-related recommendations (table 1.5). Often, no detail on the type of fertilizer recommendation was given. More frequently an increased dosage was recommended rather than a reduction in use. There was no quantitative information given on the composition, type, or dosage of fertilizer in the ICRs. A small number of projects conducted fertilizer research and quality improvement. Fertilizer recommendations were most common in SAR and EAP (38 and 36 percent of projects, respectively) compared with 28 percent of projects in AFR. In all three regions, when a project expressed fertilizer recommendations these were more likely advocating a higher dose of inorganic fertilizer than recommending lower, split, or "exact" dosage: six projects in AFR, five projects in SAR, and four projects in EAP recommended higher inorganic fertilizer dosage. Decreased/exact or split fertilizer dosage was suggested in four AFR projects and in two projects in Asia.

FIGURE 1.9. TYPES OF SEED SECTOR INTERVENTIONS



Pesticide use. There were 35 projects that commented on pesticide use. Most of the recommendations advocated IPM practices and the use of bio-pesticides; there were a few projects (in China, Burundi, Guinea Bissau, and Madagascar) that complained about the role of the extension service in advocating extensive pesticide use (table 1.6). Regional

TABLE 1.5. INORGANIC FERTILIZER INTERVENTIONS INCLUDED IN THE RICE PORTFOLIO

Rice-Related Inorganic Fertilizer Use	No. of Projects
– "Fertilizer recommendations" mentioned—no detail	18
– Increased fertilizer dose recommended	15
– Decreased or split fertilizer dose recommended	6
– Fertilizer quality improvements and research	7

TABLE 1.6. PESTICIDE-RELATED INFORMATION PRESENTED IN THE ICRS

Pesticide-Related Information Included in the ICRs	No. of Projects
– Advocated the use of IPM and "bio-pesticides," low-residue pesticides	30
– Found pesticides were too expensive for farmers to use	5
– Felt that too much was used because of extension service advocating it	4
– Not enough was used because of the absence of a distribution network	1

FIGURE 1.10. ORGANIC FERTILIZER USE IN RICE PRODUCTION

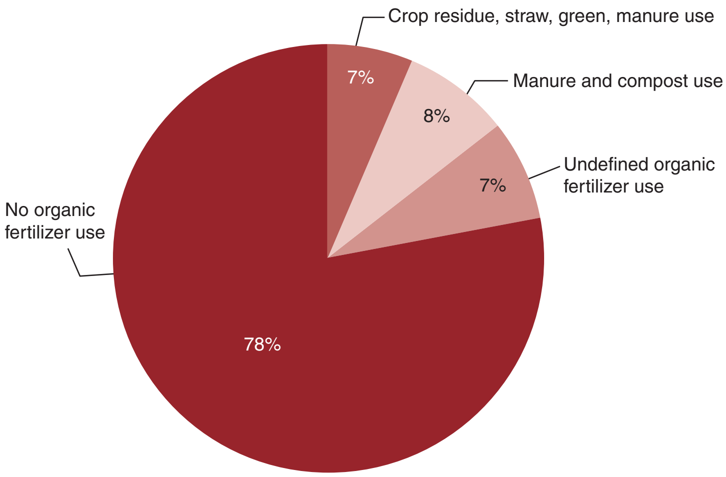
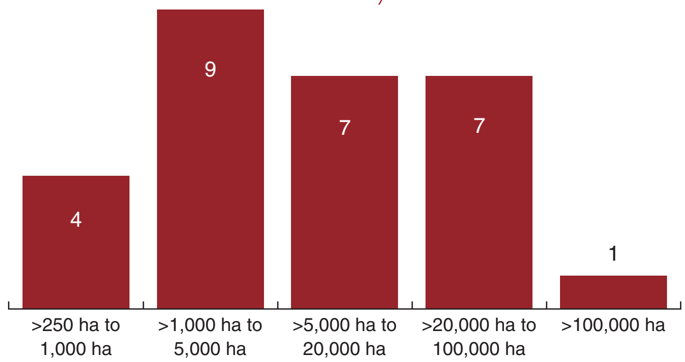


FIGURE 1.11. RICE-GROWING AREA AFFECTED BY THE PROJECT (NUMBER OF PROJECTS PER CATEGORY)



differences exist: whereas in AFR and SAR less than 18 percent of projects included a reference to pesticide use, 36 percent of projects in EAP referred to it, and almost without exception these mentioned the introduction of IPM.

Organic fertilizer use in rice production was promoted by one-fifth of the rice-related projects (in 36 projects)—the amounts or frequencies of application, however, were not mentioned in the ICRs (figure 1.10). One-third of the dedicated rice projects included the use of organic fertilizer ($n = 12$)—only one-fifth of the nondedicated projects discussed the use of organic fertilizer. Regional differences exist: whereas 28 percent of projects in SAR applied organic fertilizer, only 17 and 19 percent of projects in AFR and EAP, respectively, included this practice. The application of organic fertilizer is considered a climate-Smart practice, mitigating greenhouse gas emissions. This positive effect, however, was not mentioned in the ICRs.

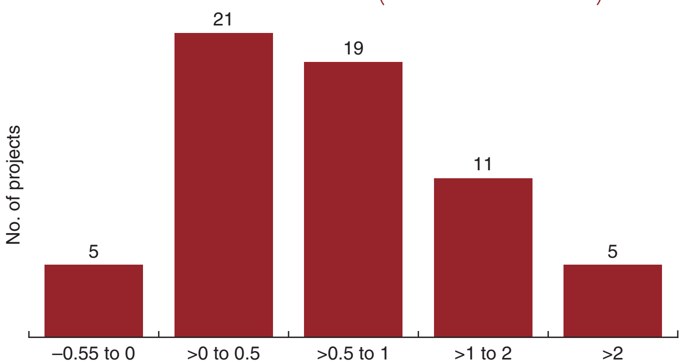
RICE-GROWING AREAS AFFECTED BY THE PROJECTS AND RICE YIELD DEVELOPMENT AS A RESULT OF PROJECT INTERVENTIONS

The rice-growing area directly affected by the projects ranged widely—between 250 ha (Burundi, Myunga Ag Dev Project Number P000195) and 364,000 ha (Nigeria Multistate Ag Dev, Project Number P002062) (figure 1.11). One project in India claimed that it affected an area of 2 million ha of no till technology under wheat/rice systems (Project Number P010561, National Agriculture Technology project from 1989). Only 20 percent of all reviewed projects ($n = 28$ projects) quantified the area affected. Of the dedicated rice projects, only 16 percent ($n = 6$) quantified the area affected by the interventions. The average area affected by projects in AFR was about a third compared with the area in EAP.

Just over one-third of all ICRs (61 projects) provided rice yield data (sometimes before and after or with and without project yield data; sometimes just the incremental increase was mentioned). In some cases, projects provided data for two different rice-growing systems. Three projects reported a yield decline over the course of the project, citing bad weather patterns or the absence of suitable varieties as reasons (Project Numbers P000818, P002772, and P001518). The majority of projects reported yield increases between 0.5 t and 1 t per hectare over the course of the project (figure 1.12). The highest reported yield increase was 3.7 t per ha (from 1.8 t before to 5.5 t at the end of the project; Office du Niger, Project Number P001718, from 1988). In some projects, yield stabilization was already seen as a success, for example, where the project managed to stem or reverse the effects of salinization (for example, India UP Sodic Lands, Project Number P009961).

The yield results reported by projects varied significantly—one determining factor is the farming system. The

FIGURE 1.12. YIELD INCREASE OF RICE PROJECTS (TONS PER HA)



average yield achieved in irrigated systems is almost twice as high as in rain-fed systems (table 1.7). And whereas the lower end of the range of achieved yields of 1 t per ha is the same for both systems, irrigated rice achieved up to 9.6 t per ha, but rain-fed systems reached less than half that amount. Average yield increases over the course of a project were also more moderate in rain-fed systems, with 0.7 t per ha versus 1 t per ha in irrigated systems. Interpreting the correlation of the yield responses to the types of interventions, and especially to the sustainable rice-growing practices, presents a mixed picture—substantial yield increases can be gained through irrigation infrastructure improvements in the absence of sustainable rice intensification practices. The introduction of salt-resistant varieties and irrigation improvements in Senegal, for example, increased the yield from an already fairly high level of 4.5 t to 5.9 t per ha (Project Number P002343 from 1988), although apparently none of the sustainable production principles were applied in that project. At the same time in Tanzania, also in an irrigated system, yields increased from a moderate 1.1 t to 1.7 t per ha with the application of several sustainable rice-growing practices (Project Number P067103, 2003). In Madagascar, a host of projects, including different combinations of sustainable rice production practices and improved varieties combined with an emphasis on improving the extension service, achieved yield increases between 43 and 188 percent in five projects over time (P001521, P001522, P001537, P001546, P001563 between 1989 and 1997).

The relative yield increase in rain-fed systems appears to be greater than for irrigated systems. The average irrigated rice yield increase achieved in AFR compared with EAP was significantly higher—starting from the same before project average (table 1.8). The database for the statistics, however, is weak and interpretations have to be made cautiously, especially because yearly yield fluctuations—usually greater in rain-fed systems—are masked by the average changes over the life span of the projects that are

TABLE 1.7. RICE YIELDS IN IRRIGATED AND RAIN-FED SYSTEMS

Rice Yield Results at End of Project (t/ha)	Rain-Fed Rice Systems (*n* = 18)	Irrigated Rice Systems (*n* = 41)
Average rice yield	2.2 t	4.0 t
Yields achieved at end of project	1 t to 4.4 t	1 t to 9.6 t
Average rice yield increase	0.7 t	1 t

TABLE 1.8. REGIONAL RICE YIELD DIFFERENCES

	Rain-Fed Rice Systems				Irrigated Rice Systems			
	N	Yield Average Before Project	Average Yield Increase	Avg. % Yield Change	N	Yield Average Before Project	Average Yield Increase	Avg. % Yield Change
AFR	9	1.6	0.6	65	13	3.9	1.2	53
EAP	1	2.0	1.0	100	15	3.9	0.8	31
SAR	2	2.3	0.6	32	6	3.6	1.0	51
LAC	1	4.1	1.9	89	1	2.2	0.7	43
MNA	-	-	-	-	1	3.9	2.4	159

usually reported in the ICRs. A major gap in interpreting the yield results is the role of the reduction in water use caused by sustainable rice production practices. None of the seven projects that practiced AWD included yield data in the ICRs.

ECONOMIC DESCRIPTORS—ERR, INCOME, AND PRODUCTION VOLUME INCREASE

The economic rate of return to investments was calculated and reported by only 72 of the projects (table 1.9). The value of the ERR ranged between 3 percent and 100 percent. The average ERR for projects in the Agriculture Global Practice is 34 percent—compared with 22 percent for all Bank projects (appendix D). The average ERR of the 72 projects is 25 percent. No correlation or differences could be found between the ERR and the type of intervention, region, or age of the projects. However, among these 72 projects were two operations that had explicitly followed SRI principles; these had calculated the ERR to be 44 percent and 47 percent, respectively. Of the 72 projects that reported an ERR, 50 reported the ERR at appraisal as well as the ERR at evaluation. For 28 of them, the ERR was corrected downward at evaluation; for 22 of them the ERR was higher at evaluation (three of these had explicitly included SRI principles). Other economic descriptors used in the ICRs were higher farm incomes and higher returns per hectare through reduced input costs and increased rice production volume. Although 30 percent (52 projects) included economic descriptors, the information was most often qualitative. Less than half of the projects that mentioned a rice production volume increase (n = 23) actually quantified the incremental increase. The production increase ranged from 126 t to 642,000 t.

TABLE 1.9. ECONOMIC DESCRIPTORS USED IN THE ICRS

Economic Descriptors Used in ICRs	Number of Projects
– Economic rate of return	72
– Production volume increase	49
– Household or per ha income increase	9
– Increased cropping intensity	8
– Reduced input costs for fertilizer and pesticides	3
– Higher price achieved for quality seeds produced	2

Box 1.2 lists the five projects that had quantified income benefits. Two of these projects explicitly refer to SRI principles being applied.

GENDER CONSIDERATIONS IN THE RICE PORTFOLIO

All ICRs were systematically tracked for references to the role of women in rice systems. The inclusion of gender issues that were found were all from countries in AFR. In Mali, Côte d'Ivoire, Madagascar, Mauretania, and Guinea Bissau rice was referred to as a woman's crop. Projects in Madagascar, Mauritania, and Côte d'Ivoire reacted to this by focusing the rice interventions on female farmers, and by increasing the number of female extension agents in the hope to better reach them (Madagascar: Project Number P001521, Mauretania: Project Number P001864, Côte d'Ivoire: Project Number P001193, Project Number P037588). In Mali, the crop diversification theme away from cotton and rice therefore especially

BOX 1.2. EXAMPLES OF PROJECTS THAT QUANTIFIED INCOME BENEFITS

- Madagascar Ag Extension Pilot Project (1990, $3.7 million, P001521): $400 per ha increase of net farm income because of SRI principles applied.
- Cambodia Ag Productivity Improvement Project (1997, $27 million, P004033): 13% more income per ha mainly through reduced pesticide cost (SRI principles were applied).
- Philippines, Second Irrigation Operations Project (1991, $53 million, P004589): 13% more income per ha because less was spent on pesticides.
- Indonesia Upland Area Development Project (1991, $15 million, P003912): net return doubled from Rp 730 to Rp 1,455 per ha rice.
- Nigeria, Fadama I (1992, $67 million, P002148): 497% higher return per ha because of irrigation improvements.

Note: Rp = rupiah.

targeted female farmers (Project Number P001744, 1990). In Guinea Bissau, the banning of slash-and-burn practices displaced women farmers from their highland rice production (Project Number P083453, 2005). Gender issues in relation to rice production were mentioned only in Madagascar, where 50 percent of newly appointed extension agents were women and involved in the wetting and drying demonstration plots in farmers' fields (P001521). Eija Pehu cautions that one needs to carefully look at the labor implications of the sustainable rice production practices. In particular, the organic fertilizer production and application, and the alternate wetting and drying practices and resulting additional weed management needs could become female tasks.[9]

THE ROLE OF EXTENSION IN DISSEMINATING SUSTAINABLE RICE-MANAGEMENT PRACTICES

The crucial role of extension and training in explaining and disseminating the complexity of sustainable rice practices to farmers was commented on in six projects—in three cases these were positive comments, recognizing that project success was due to an early and close integration of extension services with technical project interventions. In the other three cases the comment was negative—the potential of sustainable rice intensifications was not fully realized because the outreach to farmers was lacking (in scope or quality) or came too late. Overall, 25 projects comment on the importance of extension outreach to achieve the goals of the project—in 16 cases these comments were negative, blaming the absence of extension for a low level of success of project interventions. A sentiment that was often shared in the review comments was that extension and training should have been a focus of the projects earlier on, and that the quality of staff, and the reach of the extension system were criticized for being low. This project comment sums up these sentiments: "Some effective but knowledge-intensive technologies did not lend themselves well for spontaneous replication, e.g., direct sowing or intensive rice systems which require precise water management" (Madagascar, Project Number P01537, 1997).

PERFORMANCE ANALYSIS

The ratings for project Outcome, Sustainability, and Institutional Development Impact of the rice portfolio were slightly higher than the long-term average for the Agriculture Global Practice (table 1.10) (see appendix D for details on the database).

The overall Outcome rating for the "good practice" group of 19 projects is quite favorable (table 1.11); two-thirds received a Likely rating. However, a lower share

TABLE 1.10. OUTCOME RATINGS OF THE RICE PORTFOLIO COMPARED WITH OTHER AGRICULTURE GLOBAL PRACTICE PROJECTS

Indicator	Number of Projects Rated	Percentage Rated Likely/Substantial	Percentage of Agriculture GP Projects Rated Likely/Substantial
Outcome	160	73	68
Sustainability	107	51	51
Inst. development impact	111	45	43

TABLE 1.11. RATINGS OF THE 19 GOOD PRACTICE PROJECTS

Indicator	Projects Rated Likely/ Substantial	Projects Rated Not Likely/Substantial	Not Rated
Outcome	15	4	0
Sustainability	3	8	8
Institutional Development Impact	4	7	8

[9] Personal communication.

TABLE 1.12. IEG RATINGS OF THE 19 GOOD PRACTICE PROJECTS

IEG Rating	Dedicated Projects	Nondedicated Projects
HS	1	0
S	3	2
MS	5	5
MU	1	1
U	0	1
Total	**10**	**9**

Note: HS = highly satisfactory, S = satisfactory, MS = moderately satisfactory, MU = moderately unsatisfactory, U = unsatisfactory.

of these projects received favorable Sustainability and Institutional Development Impact ratings. It cannot be concluded, however, whether the favorable ratings are directly related to the sustainable practices advocated by the project because most projects included a variety of interventions and focused on more than one crop.

Based on Independent Evaluation Group (IEG) reviews, 84 percent of projects that combined one or more of the key sustainable rice production practices achieved a moderately satisfactory rating of Better. Table 1.12 shows the review of the different ratings of the projects as reported in the IEG reviews.

FINAL REMARKS AND EXPERT COMMENTS

The adaptability and scalability of sustainable rice production practices are major advantages over more conventional practices on which the Bank and its partners are well placed to capitalize. The adoption of new management principles within these institutions has similarly marked a departure from traditional ways of doing business in supporting rice intensification. Strong farmer organizations that are well served by effective extension services and responsive agricultural research are likewise well placed to facilitate the necessary change in mind-set among their member producers. The experience of these rice-related projects that promote the adoption of sustainable practices has also shed considerable light on the type of policies that are most useful in establishing contexts that encourage the scaling up of demonstrably successful sustainable practices.

The experts consulted in the preparation of this report proved to be rich sources of insight that is not necessarily found in the formal accounts of implementation completion reports. Chris Jackson, who served as the task team leader of the Agriculture Competitiveness Project in Vietnam (Project Number P108885), stressed the need for government buy-in and support, community efforts, and the role of extension in promoting adoption of the new approach to rice cultivation. "In order to apply alternate wetting and drying practices for rice production it was necessary to build community confidence by working with collective farmer groups—each farm with an average size of 0.6 hectares—to take part in the new rice production technique."[10] Jackson also noted the importance of outreach to famer cooperatives to create community-level awareness of good water management techniques, and the usefulness of "Seeing Is Believing" demonstrations at farmer field schools in disseminating previously unfamiliar practices.

For World Bank Lead Agricultural Specialist Willem Janssen, who has been following the spread of SRI principles since the beginning and successfully applied them in Tamil Nadu and other states in India, the key point of sustainable rice intensification is that it focuses on agronomy. This is also its key challenge, because agronomic changes are much more location specific and much more knowledge and management intensive, making them more difficult to prescribe. He suggests that SRI needs to be linked with strengthening of advisory services and with farmer training programs. "That makes it a more laborious system at farmer level and at project level. We should however not shy away from those complications because they resemble completely how climate smart agriculture will pan out: substituting inputs with knowledge and management."[11] SRI breaks away from and transcends the productivity paradigm and emphasis on germplasm that has characterized so much agricultural research in rice. That focus on overall productivity relied on the homogeneity of flooded, irrigation rice systems to facilitate the dissemination of improved varieties over very large areas, Jannsen notes, whereas SRI starts from a soil management perspective. "It is building an alternative productivity pathway. Those paradigms are not necessarily incompatible, but they

[10] Chris Jackson (personal communication).

[11] Willem Janssen (personal communication).

compete for funding, scientific attention and require rather different support systems. And at least until recently, SRI was a new paradigm that was less researched, and by definition more location specific and variable in its outcomes, and therefore vulnerable to criticism."[12]

Erika Styger at the SRI International Networking and Resource Center at Cornell University cautions that project planners should not lapse into prescriptive steps and fixed regimes, because doing so limits farmers' learning and adaptations.[13] Such a lapse can jeopardize the scalability of sustainable rice practices, which in turn would undermine the built-in risk management of farmers being able to experiment with the new practices on designated plots before introducing them more widely. Project design and planning should also incorporate an element of reconnaissance to identify any existing uses of sustainable rice production that are already in place in local contexts. Styger notes that in China, for instance, SRI principles were adopted by the national research system and were incorporated into their work in the mid-2000s. SRI-RICE compiled evidence from more than 50 countries on the positive yield effects of sustainable rice intensification practices.[14] Many projects included the introduction of new varieties without exploring the potential additional yield effect of also introducing rice intensification practices. This represents a missed opportunity to increase not only yield and incomes but also climate cobenefits.

World Bank task teams and project implementers are often encouraged to partner or consult with Consultative Group on International Agricultural Research (CGIAR) centers when the center's research relates to project objectives. Two such centers in particular, the International Rice Research Institute (IRRI) and the Africa Rice Center ("AfricaRice"), have regional mandates that make them natural partners for task teams working on rice projects that seek to incorporate SRI or other principles of sustainability. The centers' mandates tend to revolve more narrowly around advances in rice germplasm than the broader perspective that proponents of SRI and similar approaches subscribe to, although certain practices such as wetting and drying are the focus of both.[15] According to Styger, "this is sometimes making it unnecessarily challenging for the national partners who in some cases establish separate trials for germplasm improvement and for plant and water management principles such as SRI, because of the different research partners and their philosophies, rather than being able to combine research efforts."[16] The World Bank can facilitate a further convergence of these research efforts in the interest of common food security and poverty reduction development objectives. Planned World Bank projects with sustainable rice intensification components in West Africa, India (Tamil Nadu and Bihar), and Vietnam present such opportunities.

[12] Ibid.

[13] Styger personal communication.

[14] For more on the program: http://sri.cals.cornell.edu/index.html.

[15] IRRI 2014. Overview of AWD. Brochure; it can be found here: http://irri.org/resources/publications/brochures/overview-of-awd.

[16] Erika Styger (personal communication).

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APPENDIX A

LIST OF THE 172 PROJECTS INCLUDED IN THE REVIEW—SORTED BY REGION AND COUNTRY

Project ID	Document Name	Region	FY	Practice	SB	US$, Millions
P113374	Benin—Benin: Emergency Food Security Support	AFR	2009	AGR	ARD	9.0
P120052	Benin—Emergency Support To Enhance Food Security	AFR	2010	AGR	ARD	9.6
P000274	Burkina Faso—Agricultural Research	AFR	1988	NA	ARD	17.9
P000295	Burkina Faso—Agricultural Sector Adjustment Credit	AFR	1992	SURR	ARD	28.0
P000296	Burkina Faso—2nd National Agricultural Services Development	AFR	1998	AGR	ARD	41.3
P000195	Burundi—Muyinga Agricultural Development	AFR	1988	NA	ARD	10.0
P064558 P085981	Burundi—Agricultural Rehab and Sustainable Land Management	AFR	2005	AGR	ARD	55.0
P113438	Burundi—Food Crisis Response Development Policy Grant	AFR	2009	MEFM	EP	10.0
P000468	Central African Republic—Agricultural Services Development	AFR	1992	SURR	ARD	25.8
P113221	Central African Republic—Food Crisis Response	AFR	2009	SURR	ARD	7.0
P000501	Chad—Agricultural and Livestock Services	AFR	1995	AGR	ARD	24.5
P000604	Comoros—Pilot Agricultural Services	AFR	1997	SURR	ARD	1.6
P001165	Côte d'Ivoire—Economic Recovery Credit	AFR	1995	MEFM	EP	100.0
P001193	Côte d'Ivoire—National Agricultural Services	AFR	1994	AGR	ARD	21.8
P035603	Côte d'Ivoire—Agricultural Sector Adjustment Credit	AFR	1996	AGR	ARD	150.0
P037588	Côte d'Ivoire—Second National Agricultural Services Support	AFR	1999	AGR	ARD	50.0
P000818	Gambia—Agricultural Services	AFR	1993	AGR	ARD	12.3
P119892	Gambia—Emergency Agriculture Production	AFR	2010	AGR	ARD	7.5
P000946	Ghana—Natural Resource Management	AFR	1998	ENV & NR	ENV	9.3
P000968	Ghana—Agricultural Services Sub sector Investment	AFR	2001	AGR	ARD	67.0
P039887	Ghana—Agricultural Sector Adjustment Credit	AFR	1995	AGR	ARD	5.0

Project ID	Document Name	Region	FY	Practice	SB	US$, Millions
P110147 P102675	Ghana—First and Second Ag Development Policy Operations	AFR	2008	AGR	ARD	50.0
P122808 P122796	Ghana—Third and Fourth Ag Development Policy Operation	AFR	2011	AGR	ARD	107
P001049	Guinea—National Seeds	AFR	1988	NA	ARD	9.0
P001064	Guinea—National Agricultural Research and Extension	AFR	1989	NA	ARD	18.4
P001065	Guinea—National Rural Infrastructure	AFR	1990	NA	TRANS	40.0
P001081	Guinea—National Agricultural Services	AFR	1996	AGR	ARD	35.0
P113268	Guinea—Emergency Agricultural Productivity Support	AFR	2009	AGR	ARD	5.0
P113625	Guinea Food Crisis Response Development Policy Grant	AFR	2009	Poverty	PR	2.5
P049513 P083453	Guinea-Bissau—Coastal and Biodiversity Management	AFR	2005	ENV & NR	ENV	3.0
P113468	Guinea-Bissau—Emergency Food Security Response	AFR	2009	AGR	ARD	5.0
P120214	Guinea-Bissau—Emergency Food Security Support	AFR	2010	AGR	ARD	4.3
P112107	Liberia—Emergency Food Support for Vuln Women and Children	AFR	2008	SURR	ARD	4.0
P001518	Madagascar—Forest Management and Protection	AFR	1988	NA	ARD	7.0
P001521	Madagascar—Agricultural Extension Pilot	AFR	1990	NA	ARD	3.7
P001522	Madagascar—Second Irrigation Rehabilitation	AFR	1995	Water	ARD	21.2
P001537	Madagascar—Second Phase Environment	AFR	1997	ENV & NR	ENV	30.0
P001544	Madagascar—Economic Management and Social Action	AFR	1989	NA	FS	22.0
P001546	Madagascar—National Agricultural Research	AFR	1989	SURR	ARD	24.0
P001563	Madagascar—Agricultural Extension Support	AFR	1995	AGR	ARD	25.2
P051922	Madagascar—Rural Development Support	AFR	2001	AGR	ARD	89.1
P001718	Mali—Office du Niger Consolidation	AFR	1988	AGR	ARD	39.8
P001725	Mali—Agricultural Services	AFR	1991	AGR	ARD	24.4
P001738	Mali—Pilot Private Irrigation Promotion	AFR	1997	SURR	ARD	4.2
P001744	Mali—Agricultural Sector Adjustment/Investment	AFR	1990	AGR	ARD	53.0
P001751	Mali—National Agricultural Research	AFR	1994	AGR	ARD	20.0
P001755	Mali—Agricultural Trading and Processing Promotion	AFR	1995	AGR	ARD	6.0
P001837	Mauritania—Agricultural Sector Adjustment and Investment	AFR	1990	NA	ARD	25.0
P001864	Mauritania—Agric Services	AFR	1994	AGR	ARD	18.2
P044711	Mauritania—Mr Integ Dev Prog For Irrigated Agric	AFR	2000	SURR	ARD	38.1
P001799	Mozambique—Agricultural Sector Public Expenditure	AFR	1999	SURR	ARD	30.0
P001968	Niger—National Agricultural Research	AFR	1990	SURR	ARD	19.9
P113222	Niger—Niger: Emergency Food Security Support	AFR	2009	AGR	ARD	7.0
P002062	Nigeria—First Multistate Agricultural Development	AFR	1986	NA	ARD	162.0
P002124	Nigeria—Third Multi-State Agricultural Development	AFR	1989	NA	ARD	100.9
P002140	Nigeria—National Agricultural Technology Support	AFR	1992	AGR	ARD	42.5
P002143	Nigeria—National Seed and Quarantine	AFR	1990	AGR	ARD	14.0
P002148	Nigeria—National Fadama Development	AFR	1992	SURR	ARD	67.5
P058038	Rwanda—Agricultural and Rural Market Development	AFR	2000	AGR	ARD	5.0
P105176	Rwanda—Second Rural Sector Support	AFR	2008	AGR	ARD	35.0
P002331	Senegal—Agricultural Service	AFR	1990	AGR	ARD	17.1

Project ID	Document Name	Region	FY	Practice	SB	US$, Millions
P002343	Senegal—Fourth Irrigation	AFR	1988	NA	ARD	33.6
P002351	Senegal—Second Agricultural Research	AFR	1990	NA	ARD	18.5
P002356	Senegal—Agricultural Sector Adjustment	AFR	1995	AGR	ARD	45.0
P002402	Sierra Leone—Agriculture Sector Support	AFR	1984	SURR	ARD	21.5
P079335	Sierra Leone—Sierra Leone-National Social Action	AFR	2003	SP	SP	35.0
P113219	Sierra Leone—Sl-dpl-food Crisis Response	AFR	2009	SP	SP	3.0
P002772	Tanzania—National Agr and Livestock Extension Rehab	AFR	1989	NA	ARD	18.4
P002801	Tanzania—Agricultural Sector Management (ASMP) Projet	AFR	1994	SURR	ARD	24.5
P002804	Tanzania—Second Agricultural Research	AFR	1998	SURR	ARD	21.8
P067103	Tanzania—Participatory Ag Development and Empowerment	AFR	2003	AGR	ARD	56.6
P114291	Tanzania—Accelerated Food Security	AFR	2009	AGR	ARD	160.0
P002856	Togo—Cotton Sector Development	AFR	1988	NA	ARD	15.1
P002948	Uganda—Southwest Region Agricultural Rehabilitation	AFR	1988	NA	ARD	10.0
P044695	Uganda—National Agricultural Advisory Services	AFR	2001	AGR	ARD	45.0
P086513	Uganda—Millennium Science Initiative	AFR	2006	EDU	EDU	30.0
P105649	Uganda—Second Phase of the Ag Research and Training	AFR	2008	AGR	ARD	12.0
P003218	Zambia—Agricultural Sector Investment	AFR	1995	SURR	ARD	60.0
P004033	Cambodia—Agriculture Productivity Improvement	EAP	1997	SURR	ARD	27.0
P117203	Cambodia—Smallholder Ag And Social Protection Support	EAP	2010	AGR	ARD	5.0
P003474	China—Northern Irrigation	EAP	1988	NA	ARD	103.0
P003559	China—Agricultural Support Services	EAP	1993	AGR	ARD	115.0
P003560	China—Henan Agricultural Development	EAP	1991	AGR	ARD	110.0
P003561	China—Sichuan Agricultural Development	EAP	1993	Water	ARD	147.0
P003582	China—Irrigated Agriculture Intensification	EAP	1991	Water	ARD	335.0
P003593	China—Songliao Plain Adp	EAP	1994	AGR	ARD	205.0
P003595	China—Songliao Plain Agricultural Development	EAP	1994	AGR	ARD	150.0
P003627	China—Grain Distribution and Marketing	EAP	1993	AGR	ARD	490.0
P003638	China—Seed Sector Commercialization	EAP	1996	AGR	ARD	100.0
P049665	China—Anning Valley Agricultural Development	EAP	1999	AGR	ARD	120.0
P049700	China—Second Irrigated Agriculture Intensification	EAP	1998	AGR	ARD	300.0
P065463	China—Jiangxi Integrated Agricultural Modernization	EAP	2004	Water	ARD	100.0
P003912	Indonesia—Yogyakarta Upland Area Development	EAP	1991	NA	ARD	15.5
P003934	Indonesia—Agricultural Research Management	EAP	1989	NA	ARD	35.3
P003937	Indonesia—Integrated Swamps Development	EAP	1994	SURR	ARD	65.0
P003972	Indonesia—Second Agricultural Research Management	EAP	1995	AGR	ARD	63.0
P003981	Indonesia—Provincial Irrigated Agriculture Development	EAP	1991	Water	ARD	125.0
P003985	Indonesia—National Watershed Management and Conservation	EAP	1994	ENV & NR	ENV	56.5
P004009	Indonesia—Integrated Pest Management Training	EAP	1993	AGR	ARD	32.0
P004011	Indonesia—Sulawesi Agri Area	EAP	1996	SURR	ARD	26.8
P059930	Indonesia—Decentralized Agricultural and Forestry Extension	EAP	2000	SURR	ARD	18.0
P110635	Indonesia—Nias Islands Livelihoods and Economic Development	EAP	2010	SURR	Urban Development	8.2

Project ID	Document Name	Region	FY	Practice	SB	US$, Millions
P120313	Indonesia—Climate Change Development Policy Loan	EAP	2010	ENV & NR	ENV	200.0
P004195	Laos—Upland Agriculture Development	EAP	1990	AGR	ARD	20.2
P059305	Laos—District Upland Development And Conservation	EAP	1999	SURR	ARD	2.0
P114617	Laos—Lao Pdr: Rice Productivity Improvement	EAP	2009	AGR	ARD	3.0
P003363	Myanmar—Grain Storage and Processing	EAP	1986	NA	ARD	30.0
P003364	Myanmar—Second Seed Development	EAP	1985	NA	ARD	14.5
P004572	Philippines—Second Communal Irrigation Development	EAP	1991	Water	ARD	46.2
P004589	Philippines—Second Irrigation Operations Support (IOSP II)	EAP	1993	Water	ARD	51.3
P037079	Philippines—Agrarian Reform Communities Development	EAP	1997	SURR	ARD	50.0
P058842	Philippines—Mindanao Rural Development	EAP	2000	SURR	ARD	27.5
P113492 P120564	Philippines—Food Crisis Response Dev Policy Operation	EAP	2009	SURR	SP	450.0
P070533	Timor-Leste—Agriculture Rehabilitation	EAP	2000	AGR	ARD	6.8
P073911	Timor-Leste—Second Agriculture Rehabilitation	EAP	2002	AGR	ARD	8.0
P079320	Timor Leste—Third Agriculture Rehabilitation	EAP	2004	AGR	ARD	3.0
P004834	Vietnam—Irrigation Rehabilitation	EAP	1995	Water	ARD	100.0
P004837	Viet Nam—Agricultural Rehabilitation	EAP	1994	SURR	ARD	96.0
P004844	Vietnam—Vn-agric. Diversification	EAP	1998	AGR	ARD	66.9
P108885	Vietnam—Agriculture Competitiveness	EAP	2009	AGR	ARD	59.8
P040544	Azerbaijan—Farm Privatization	ECA	1997	SURR	ARD	14.7
P049721	Kazakhstan—Agricultural Competitiveness	ECA	2005	AGR	ARD	24.0
P006152	Bolivia—Eastern Lowlands NRM and Ag Production	LAC	1990	ENV & NR	ENV	35.0
P006372	Brazil—Second Agricultural Extension	LAC	1986	NA	ARD	155.0
P007100	Ecuador—Lower Guayas Flood Control	LAC	1991	SURR	ARD	59.0
P007105	Ecuador—Irrigation Subsector Technical Assistance	LAC	1994	SURR	ARD	20.0
P007115	Ecuador—Rural Development	LAC	1992	TRAN	TRAN	84.0
P007167	El Salvador—Agricultural Sector Reform and Investment	LAC	1993	AGR	ARD	40.0
P095169	Multi-Country Cap-Building for Compliance with the Cartagena Protocol on Biosafety	LAC	2008	AGR	ARD	4.0
P007633	Mexico—Second Tropical Agricultural Development	LAC	1986	NA	ARD	109.0
P007682	Mexico—Agricultural Technology	LAC	1992	AGR	ARD	150.0
P048505	Mexico—Agricultural Productivity Improvement	LAC	1999	AGR	ARD	444.5
P007780	Nicaragua—Ag Technology and Land Management	LAC	1994	ENV & NR	ENV	44.0
P064915	Nicaragua—Ag Technology & Rural Technical Education	LAC	2000	SURR	ARD	23.6
P087046	Nicaragua—Second Agricultural Technology	LAC	2006	AGR	ARD	12.0
P007918	Paraguay—Natural Resources Management	LAC	1994	SURR	ARD	50.0
P008037	Peru—Irrigations Subsector	LAC	1997	Water	ARD	85.0
P008133	Uruguay—Second Agricultural Development	LAC	1990	AGR	ARD	65.0
P008173	Uruguay—NRM and Irrigation Development	LAC	1994	Water	ARD	41.0
P008214	Venezuela—Agricultural Sector Investment	LAC	1992	SURR	ARD	300.0
P112017	Djibouti—Djibouti—Food Crisis Response Dev Policy Grant	MNA	2008	MEFM	EP	5.0

Project ID	Document Name	Region	FY	Practice	SB	US$, Millions
P005146	Egypt—National Drainage	MNA	1992	Water	ARD	120.0
P049166	Egypt—East Delta Agriculture Services	MNA	1998	SURR	ARD	15.0
P009461	Bangladesh—BWDB System Rehabilitation	SAR	1990	NA	ARD	53.9
P009476	Bangladesh—Shallow Tubewell and Low-lift Pump Irr	SAR	1991	NA	ARD	75.0
P009484	Bangladesh—Agriculture Research Management	SAR	1996	AGR	ARD	50.0
P009516	Bangladesh—Agriculture Support Services	SAR	1991	NA	ARD	35.0
P009519	Bangladesh—Third Fisheries	SAR	1990	NA	ARD	44.6
P009544	Bangladesh—National Minor Irrigation Development	SAR	1991	NA	ARD	54.0
P112761	Bangladesh Food Crisis Development Support Credit	SAR	2009	MEFM	EP	130.0
P009847	India—Second National Agricultural Research	SAR	1986	NA	ARD	72.1
P009860	India—Integrated Watershed Development (Plains)	SAR	1990	ENV & NR	ENV	62.0
P009922	India—Third National Seeds	SAR	1989	NA	ARD	150.0
P009958	India—Agricultural Development —Tamil Nadu	SAR	1991	AGR	ARD	112.8
P009961	India—Uttar Pradesh Sodic Lands Reclamation	SAR	1993	AGR	ARD	54.7
P010408	India—Bihar Plateau Development	SAR	1993	TRAN	TRAN	117.0
P010522	India—Assam Rural Infra	SAR	1995	SURR	ARD	126.0
P010529	India—Orissa Water Resources Consolidation	SAR	1996	Water	ARD	290.9
P010561	India—National Agricultural Technology	SAR	1998	AGR	ARD	196.8
P035824	India—Diversified Agricultural Support	SAR	1998	SURR	ARD	129.9
P041264	India—Integrated Watershed Development	SAR	1999	AGR	ARD	135.0
P050646	India—Second Uttar Pradesh Sodic Lands Reclamation	SAR	1999	Water	ARD	194.1
P078550 P112061 P124354	India—AF for the UT Decentr Watershed Dev, and Sust Land, Water and Biodiv Cons, and Mangmt for Improved Livelihoods in UT Watershed Sector	SAR	2004	AGR	ARD	85.1
P010348	Nepal—Bhairawa Lumbini Groundwater Irrigation III	SAR	1990	Water	ARD	47.2
P010530	Nepal—Irrigation Sector	SAR	1998	Water	ARD	79.8
P048026	Nepal—Agri Res & Extension	SAR	1998	AGR	ARD	24.3
P010372	Pakistan—Third On-Farm Water Management	SAR	1991	NA	ARD	83.6
P010377	Pakistan—Second SCARP Transition	SAR	1991	NA	ARD	20.0
P071092	Pakistan—NW Frontier Province On-Farm Water Management	SAR	2001	Water	ARD	21.4
P010276	Sri Lanka—Agricultural Research	SAR	1987	NA	ARD	18.6
P010378	Sri Lanka—National Irrigation Rehabilitation	SAR	1991	Water	ARD	29.6
P010398	Sri Lanka—Second Agricultural Extension	SAR	1992	AGR	ARD	14.3

APPENDIX B

SUSTAINABLE RICE PRODUCTION CONCEPTS USED IN THE PORTFOLIO

Several projects refer to specific sustainable rice management approaches, some of which are listed and described in this appendix.

» **System of Rice Intensification—the principles**

The System of Rice Intensification is a set of management practices that was developed in 1960 in Madagascar. Adapted and applied to other crops, its principles today have spread to more than 50 countries. The principles of rice intensifications systems promise climate cobenefits and increased production with reduced input and water use, leading to higher farm incomes. SRI presented a paradigm shift from the thinking of the Green Revolution because it does not depend on genetic change or on added inputs. It started as a bottom-up technology and is more agro-ecology based instead of input dependent. SRI is based on the principle of developing healthy large and deep root systems that can better resist drought, waterlogging, and wind damage. It consists of six key elements to better manage inputs, utilize new ways to transplant seedlings, and manage water and fertilizer application. SRI plants develop stronger stalks and more tillers, with higher yields and even better flavor qualities. SRI consists of six main elements:

1. Seed nursery—seedlings are transplanted at a much younger age, typically 8–12 days old
2. Transplanting—single seedlings are planted, instead of planting a handful of seedlings in each hill
3. Innovative transplanting—plants are spaced wider apart in a square pattern rather than in rows
4. Intermittent water application to create wet and dry soil conditions, instead of continuous flood irrigation
5. Rotary weeding to control weeds and promote soil aeration
6. Increased use of organic fertilizer to enhance soil fertility

Potential benefits are higher yields, fewer broken seeds and more milled grains, reduced water use, reduced labor demand, and reduced seed amount.

Constraints of SRI: there is an increased labor demand during the first few seasons (it actually saves labor); reliable water supply and control over irrigation quantities is required (less water is needed but it needs to be applied more frequently).

Challenges for SRI: a proper adaptation of the six principles to local conditions is required, a well-functioning extension service and on-farm demonstrations are needed, and traditions must be overcome.

Source: http://info.worldbank.org/etools/docs/library/245848/.

» The **SRI International Network and Resource Center at Cornell** bases its SRI methodology on four main principles that interact with each other:
- Early, quick, and healthy plant establishment
- Reduced plant density
- Improved soil conditions through enrichment with organic matter
- Reduced and controlled water application

A set of management practices is then defined according to the local conditions and the rice system. Adaptations are often undertaken to accommodate changing weather patterns, soil conditions, labor availability, water control, and access to organic inputs.

Source: http://sri.ciifad.cornell.edu/aboutsri/aboutus/.

» **"1 Must and 5 Reductions" in Vietnam**

In Vietnam, a similar approach has been developed. The Ag Competitiveness Project in Vietnam's Mekong Delta (Project Number P108885) promoted the government of Vietnam's *Mot Phai, Nam Giam* (1 Must and 5 Reductions) approach to rice production, which championed an alternate wetting and drying rice production technique that uses less water and reduces the application of fertilizers and management of crop residues to reduce the level of methane and nitrous oxide emissions in the rice fields. Adopting this climate-smart practice required the systematic engagement of the entire community committed to draining the rice fields multiple times over a matter of weeks, something traditionally rarely done. Adopting this alternate wetting and drying technique not only helps strengthen plant roots but also reduces flooding periods, which translates into reduced methane production.

The project promoted the government of Vietnam's novel 1 Must and 5 Reductions approach to rice production, in which producers are encouraged to use certified seed ("1 Must"); and achieve five reductions (seed rate, use of fertilizer, water use through alternate wetting and drying of the field, frequency of pesticide application, and postharvest losses) as a means to improve the overall sustainability of rice production. In order to apply alternate wetting and drying practices for rice production it was necessary to build community confidence by working with collective farmer groups—each farm with an average size of 0.6 hectares—to take part in the new rice production technique. Farmers were trained through Farmer Field Schools taking a "Seeing Is Believing" approach. Equally important was the outreach to famer cooperatives to create community-level awareness of good water management techniques.

As a result of this behavior change, farmers' up-front costs for inputs fell by 20 percent, and crop productivity increased by 5 to 10 percent, improving farmer incomes by up to one-third. In addition, the project's training and extension services, provided directly to more than 33,000 farmers in two provinces in the Mekong Delta for three cropping seasons, allowed the farmers to become aware of greenhouse gas emissions reduction achieved through the water management techniques.

The World Bank Board of Directors recently approved a new project that will scale up the impact to cover all eight rice-growing provinces of the Mekong Delta. By demonstrating the success of this kind of intervention in rice production, the new Vietnam Sustainable Agriculture Transformation Project

(VnSAT) has the potential to be expanded to other settings (additional crop rotation from rice to nonrice crops, crop management, use of biochar and fertilizer management) to demonstrate further greenhouse gas mitigation opportunities. Moreover, this project and other evidence-based climate-smart interventions can bring together development and climate finance to promote the Nationally Appropriate Mitigation Actions (NAMA) or other interventions supporting low emissions development in countries and enhance their commitment to reduce emissions and to pilot payment for environmental services (PES).

Source: http://blogs.worldbank.org/voices/slogan-sustainable-agriculture-mot-phai-nam-giam-rice-production.

- **Rice integrated crop management—Rice ICM in Indonesia**

A term coined by the Food and Agriculture Organization of the U.N. (FAO) and partners is based on the concept that rice farmers carry out numerous cultural operations during the growing season. These activities, separately and collectively, have an effect on all the phases of crop development and ultimately determine yield. Rice ICM is based on the understanding that production limitations are closely linked. For example, stronger seedlings from high-quality seeds will not benefit yield if the crop is inadequately fertilized. Similarly, the crop cannot respond to improved fertility if it is competing with weeds or if insufficient water is supplied. Many of the principles are similar to the SRI approach.

For example, for Indonesia there is a set of six recommendations:

- Selection of rice varieties for high yield and seed
- Transplanting of young and healthy seedlings
- Incorporation of organic manure and basal fertilizer into soil
- Intermittent irrigation
- Frequent mechanical weeding
- Control of pests and diseases, based on a regular field observations and early warning system

Source: http://www.fao.org/3/a-a0869t/a0869t04.pdf.

- **In the Philippines, sustainable rice production principles are known locally as Sustainable System of Irrigated Agriculture**

1. Leveling and Preparing the Field (similar to SRI)
2. Preparing the Nursery (slightly different from SRI practices by using local Dapog)
3. Innovative Transplanting of Single Seedlings (similar to SRI) when they are 8–10 days old
4. Irrigating Intermittently (similar to SRI)
5. Applying Organic Fertilizers (slightly different from SRI by emphasizing composting)
6. Rotary Weeding and Tillage (similar to SRI)

Source: http://info.worldbank.org/etools/docs/library/245848/files/docs/topic05/Resources_SSIAPaperFinal.pdf.

- **One of the core principles of all the sustainable intensification systems is the intermittent water applications, often called Alternate Wetting and Drying—saving water and reducing greenhouse gas (GHG) emissions**

AWD is a management practice in irrigated lowland rice fields that saves water and reduces GHG emissions while maintaining yields. The practice of AWD is defined by the periodic drying and reflooding of the rice field. AWD and other single- or multiple-drying practices have been used for several decades as water-saving practices. About 40 percent of rice farmers in China practice some form of water management and short intervals of nonflooded conditions are common among rice farmers in northwestern India and in Japan (more than 80 percent). AWD-like practices have continued to spread. AWD has been field tested and validated by rice farmers in Bangladesh, Indonesia, Lao PDR, the Philippines, Myanmar, and Vietnam. AWD is now being mainstreamed in extension efforts by formal extension institutes and nongovermental organizations in a number of countries in Southeast Asia. The key messages are the following:

1. AWD is a rice management practice that reduces water use by up to 30 percent and can save farmers money on irrigation and pumping costs.

2. AWD reduces methane emissions by 48 percent without reducing yield.
3. Efficient nitrogen use and application of organic inputs to dry soil can further reduce emissions.
4. Incentives for adoption of AWD are higher when farmers pay for pump irrigation.

Sources: https://ccafs.cgiar.org/research/results/putting-alternate-wetting-and-drying-awd-map-globally-and-nationally-0;

https://cgspace.cgiar.org/bitstream/handle/10568/35402/info-note_CCAFS_AWD_final_A4.pdf.

APPENDIX C
LIST OF 19 PROJECTS THAT INCLUDE CORE SUSTAINABLE RICE PRODUCTION PRACTICES

Eight projects marked with an * specifically mention an approach.

Project ID	IEG Outcome	Document Name	Region	FY	Lending Instrument	Practice	Sector Board	Lending ($US, millions)
Dedicated projects								
P108885*	MS	Vietnam—Agriculture Competitiveness Project	EAP	2009	SIL	AGR	ARD	59.8
P004033	MU	Cambodia—Agriculture Productivity Improvement	EAP	1997	SIL	SURR	ARD	27.0
P001521	S	Madagascar—Agricultural Extension Pilot Project	AFR	1990	SIL	NA	ARD	3.7
P001546	S	Madagascar—National Agricultural Research	AFR	1989	SIL	SURR	ARD	24.0
P009961	S	India—Uttar Pradesh Sodic Lands Reclamation	SAR	1993	SIL	AGR	ARD	54.7
P105176*	HS	Rwanda—Second Rural Sector Support Project	AFR	2008	APL	AGR	ARD	35.0
P001563*	MS	Madagascar—Agricultural Extension Program	AFR	1995	SIL	AGR	ARD	25.2
P001522*	MS	Madagascar—Second Irrigation Rehabilitation	AFR	1995	SIL	Water	ARD	21.2
P113221*	MS	Central African Republic—Food Crisis Response	AFR	2009	ERL	SURR	ARD	7.0
P004009	MS	Indonesia—Integrated Pest Management Training	EAP	1993	SIL	AGR	ARD	32.0
Nondedicated projects								
P000501	MS	Chad—Agricultural and Livestock Services Project	AFR	1995	SIL	AGR	ARD	24.5
P001537*	MS	Madagascar—Second Phase Environment Program	AFR	1997	SIL	ENRM	ENV	30.0
P002351	MS	Senegal—Second Agricultural Research Project	AFR	1990	SIL	NA	ARD	18.5
P067103	MS	Tanzania—Participatory Ag Dev. and Empowerment	AFR	2003	SIL	AGR	ARD	56.6
P110635	MS	Indonesia—Nias Islands Livelihoods and Ec Dev Prog	EAP	2010	ERL	SURR	Urban	8.2
P120313*	MU	Indonesia—Climate Change Development Policy Loan	EAP	2010	DPL	ENRM	ENV	200.0
P001193	S	Côte d'Ivoire—National Agricultural Services Project	AFR	1994	SIL	AGR	ARD	21.8
P009484	S	Bangladesh—Agriculture Research Management	SAR	1996	SIL	AGR	ARD	50.0
P048026*	US	Nepal—Agri Res & Extension	SAR	1998	SIL	AGR	ARD	24.3

Note: HS = highly satisfactory, MS = mostly satisfactory, S = satisfactory, MU = mostly unsatisfactory, US = unsatisfactory.

APPENDIX D

COMPARISON OF PROJECT RATINGS BETWEEN "ALL BANK" AND AGRICULTURE GLOBAL PRACTICE PROJECTS

Project Approvals between 1981 and 2014	ALL BANK	AGR GP
# Projects	8,462	272
Net Commitments	569,713.6	13,176.9
Outcome % Satisfactory	70.5	68.4
RDO % Moderate or Lower	54.4	41.3
Sustainability % Likely	55.6	50.8
Inst Dev Impact % Substantial	37.9	43.3
Bank Performance at Entry % Sat	66.6	55.6
Bank Performance at Supervision % Sat	78.2	72.5
Borrower Performance at Preparation % Sat	78.3	77.5
Borrower Performance at Implementation % Sat	70.2	64.9
Borrower Performance at Compliance % Sat	70.9	68.3
ICR Quality % Sat	91.3	89.6
Net Disconnect	20.5	25.6
Average ERR at Evaluation	22.4	34.2
Average ERR at Appraisal	26.1	26.7
Bank Overall Performance % Sat	74.4	66.4
Borrower Overall Performance % Sat	71.9	64.2

AGRICULTURE GLOBAL PRACTICE DISCUSSION PAPER 11

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