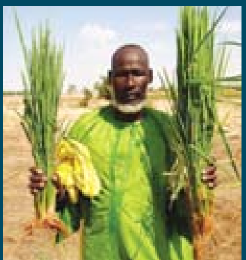
MORE RICE FOR PEOPLE
MORE WATER FOR THE PLANET

System of Rice Intensification (SRI)

Africare Oxfam WWF

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Cover Caption: SRI methods constitute a low-cost strategy for rapidly increasing the yields of smallholder rice farmers, while reducing their need for water, seed, and agrochemical inputs. Rice plants under SRI management are more productive, with stronger roots, more tillers, and more prolific grain-filled panicles. The close up of the rice plant shown on the cover comes from the field of an Indian farmer in Andhra Pradesh who increased his yield using SRI practices. Growing more rice with less water and agrochemical inputs is essential for future food security and environmental sustainability. These methods are also being extended to other crops such as wheat, finger millet, sugarcane, maize, legumes, even vegetables.

MORE RICE FOR PEOPLE
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System of Rice Intensification (SRI)

Contributing to Food Security, Farmers' Adaptability to Climate Change, and Environmental Sustainability

CONTENTS

Why rethink rice production?

When agencies as diverse as Oxfam, WWF and Africare, with missions focused respectively on social justice, human harmony with nature, and sustainable development, independently come to support the same strategy to address critical global challenges, such a strategy merits wider attention and examination.

This report highlights the experiences of Africare, Oxfam America and the Worldwide Fund for Nature (WWF) working with the System of Rice Intensification (SRI) in the African Sahel, Southeast Asia, and India, respectively. Although implemented in very different cultures and climates, the pattern is the same: farmers are able to produce more rice using less water, agrochemical inputs, and seeds, and often with less labor. The net effect is to improve household incomes and food security while reducing the negative environmental impacts of rice production, and making food production more resilient.

Rice is not only the major source of calories for half the world's population, it is the single largest source of employment and income for rural people. More of the world's poor people depend on growing and eating rice than any other food. But rice production has a significant environmental footprint. Current practices promote genetic uniformity, which makes crops more vulnerable to pests and diseases. They are also wasteful of increasingly scarce and costly resources such as water and fossil fuels, using up about one-quarter to one-third of the world's annual supply of freshwater. Heavily fertilized, continuously flooded rice fields produce greenhouse gases that contribute to global warming, and misuse of inorganic fertilizers and agrochemicals results in soil and water pollution. Further, growing rice is very labor-intensive, with women generally bearing the major burden of work along with their other household and child-rearing tasks. Following the dramatic increases in rice production achieved with Green Revolution technologies during the 1970s and 1980s, there has been a slowdown in the yield gains in many countries, with additional synthetic fertilizer inputs encountering diminishing returns.

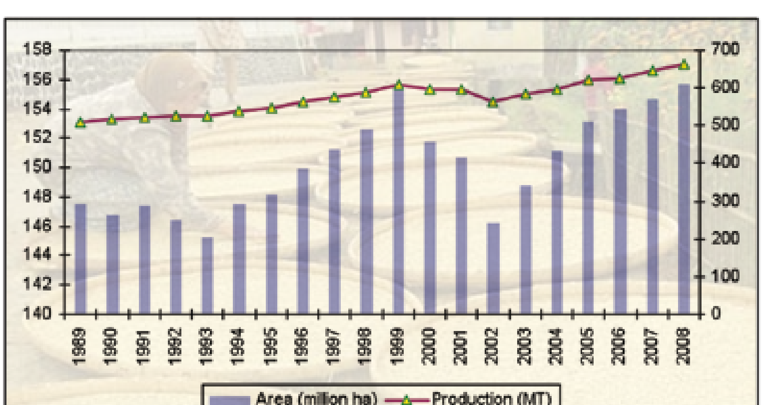
Rice is not only the major source of calories for half the world's population, it is the single largest source of employment and income for rural people.

SRI: A WIN-WIN-WIN OPPORTUNITY

Rice production will need to increase dramatically in the next decades to meet the demands of a growing population, not to mention the existing global food and nutrition deficits. This increase must be accomplished with less land per capita, smaller and less reliable water supplies, less degradation of the environment, and less drain on the resources of smallholder farmers, who constitute the majority of the world's poor. Finding local solutions to food production is essential to eliminating hunger and providing insurance against rising food prices.

The System of Rice Intensification (SRI) is perhaps the best current example of options available to farmers and nations to promote community-led agricultural growth, while managing soil and water resources more sustainably and even enhancing their future productive capacity.

SRI is a set of alternative crop management practices, developed in the 1980s in Madagascar to benefit farmers with small landholdings. SRI increases the productivity of resources used in rice cultivation, reducing requirements for water, seed, synthetic fertilizers, pesticides, herbicides and often labor—especially tasks performed



Global rice area and rough rice production (Source: IRRI World Rice Statistics)
Over the past decades, rice output has leveled off. Demand for rice is on the rise, however, as population increases. It is estimated that production must increase by 50% in 2050 to meet global food needs.

by women. SRI represents an unprecedented opportunity for developing economies to enable these households to be more productive, secure, and self-reliant, while buffering and even reversing the trends that contribute to climate change. This is a win-win-win situation for rural households, countries and the planet.

The benefits of SRI have been seen already in 40 countries, with increased production of both improved and local rice varieties. While SRI has been largely a civil society innovation, embraced by hundreds of national and local level NGOs as well as many international NGOs, the governments of Cambodia, China, India, Indonesia, and Vietnam—where over two-thirds of the world's rice is produced—have given explicit endorsement of SRI methods in their national food security programs. With World Bank assistance, farmers in the Indian state of Tamil Nadu have already applied SRI methods to over 600,000 hectares of rice land, with average water savings of 40%. Although developed for transplanted irrigated rice production, SRI concepts and methods are being extended to direct-seeded and to rainfed (unirrigated) rice cropping systems, and increasingly to other crops.

It is our hope that policy and institutional changes to support appropriate SRI research, extension and production initiatives can be accelerated once policymakers and donor organizations are more aware of the full potential of SRI methods. Present funding levels are negligible compared with public and private sector investments currently devoted to genetic improvement and external chemical inputs. Moreover, many of these programs necessarily take many years to move innovations from laboratories to farmers' fields.

Farmers, nations and the planet as a whole urgently need solutions now. Even modest investments in SRI dissemination can generate impressive immediate returns. The Tamil Nadu Minister of Agriculture credits the spread of SRI methods and its higher yields with enabling that state to raise its rice production in 2009, despite a reduction in total cropped area due to an erratic monsoon season. He reported that SRI methods are giving yields of 6 to 9 tons per hectare instead of the current average yield of 3.5 tons. With more support for the spread of SRI insights and methods, millions of farmers could be producing and eating more rice within one or two cropping seasons, while saving water and energy, reducing their production costs, and contributing to rice surpluses for urban populations.

Darius Mans
President, Africare

Raymond C. Offenheiser
President, Oxfam America

James P. Leape
Director General, WWF International

The benefits of SRI have been seen already in 40 countries, with increased production of both improved and local rice varieties.

Above photo: Tribal farmer in Jharkhand state, India, holds up his SRI rice plant, grown from a single seed. Farmers in this upland region dependent on monsoon rainfall have adapted SRI methods to cultivation without irrigation and been able to attain yields of 7 tons/hectare.

Opposite page: SRI methods are giving farmers' crops some protection against a number of climatic and other hazards. Vietnamese farmer, Nguyen Thi Bay, from Dông Trù village, Phu Tho province, holds up a SRI rice plant (left) and a conventionally grown plant (right) taken from the fields behind her after a typhoon passed through. The strong winds and rains severely lodged the conventional crop. A crop of the same variety, but using SRI practices, was not blown over.

How is SRI an innovation?

More than 90% of the world's rice production is harvested from irrigated or rainfed lowland rice fields. In these systems, rice seeds are traditionally started in a seedbed and transplanted 3-6 weeks later into a main field that is kept covered with water throughout the growing season. SRI practices and principles introduce some simple but productive changes in how rice can be grown in these systems. The following are recommended practices under SRI management compared with conventional irrigated rice production.

THE SYSTEM OF RICE INTENSIFICATION (SRI)

1. Age of seedlings

Young seedlings are transplanted at 8-12 days old.

Seedlings are carefully lifted from the nursery and transported to fields in baskets or on trays for immediate transplanting.

Seeding rate: 5-7 kg/hectare

2. Number of seedlings

1-2 seedlings per hill are transplanted with shallow depth (1-2 cm) into soils that are not flooded.

Roots are carefully positioned just under the soil surface to avoid trauma to the roots, thereby avoiding "transplant shock."

3. Spacing of plants

Wider spacing, with hills 20-30 cm apart, set out in a square or matrix pattern to facilitate moving through the field with a weeder, and to expose plants fully to the sunlight.

4. Water management

Non-flooded aerobic soil conditions with intermittent irrigation.

Where possible, small applications of water, or alternate wetting and drying during the growth period; just 1-2 cm of water on fields after the plants flower.

5. Soil fertilization

Organic matter is preferred to the extent feasible but may be complemented with synthetic fertilizers.

Combinations can be used to ensure appropriate soil:plant nutrient balance.

6. Weed and pest control

Manual weeders can remove weeds and aerate the topsoil at the same time.

Integrated Pest Management (IPM) practices are encouraged. SRI plants are generally more resistant to pests and diseases so require less chemical protection.

VS. CONVENTIONAL RICE PRODUCTION

1. Age of seedlings

Older seedlings are transplanted at 21-40 days old.

Soil is shaken from roots; and seedlings are bundled and transported to fields. Bundles are often left in the open for days.

Seeding rate: 50-75 kg/ hectare

2. Number of seedlings

3-4 seedlings (even 6-8) are clumped and pressed deep into flooded soils, resulting in closely competing seedlings with inverted roots and anaerobic soil conditions.

3. Spacing of plants

Close spacing with hills 10-15 cm apart, either in rows or more typically with random spacing.

4. Water management

Continuous flooding of paddy fields with 5-15 cm of water throughout the growing cycle.

5. Soil fertilization

Inorganic synthetic fertilizer is applied, largely replacing the application of organic matter, which enhances soil structure and functioning.

6. Weed and pest control

Flooding is supplemented by manual weeding or by herbicide applications; manual weeders cannot be used in randomly planted fields.

IPM is sometimes practiced, but pesticides are usually applied preemptively or as needed.

Benefits of SRI

MORE RICE, MORE INCOME, LESS WATER

47% Yield increase

40% Water saving

23% Reduction in costs per hectare

68% Increased income per hectare

Average of on-farm evaluations of impacts from SRI methods in eight countries. Complete table in Annex.

MORE OPTIMAL GROWING CONDITIONS

SRI practices enhance the rice plants' growing conditions by:

1. Reducing the recovery time seedlings need after transplanting;
2. Reducing crowding and competition;
3. Optimizing soil and water conditions.

These conditions contribute to:

- Larger, deeper root systems;
- Enhanced photosynthetic capacity;
- More productive plants that are more resistant to climate extremes, pests and diseases;
- More grain yield.

MORE YIELD WITH LESS INPUTS

SRI methods require:

- Less time before transplanting, as seedlings can be ready in 8-12 days instead of one month;
- 80-90% fewer seeds, due to much lower plant populations;
- Less time required for transplanting due to fewer seedlings;
- 25-50% less water, as the field is not continuously flooded;
- Less cost per hectare, as there is less need for purchased seeds, synthetic fertilizers, herbicides or pesticides, and in some countries less labor is required.

Farmers, with less expense, are able to produce more rice to eat or sell, improving both their food security and income, while further benefiting their health and the environment by using less water and agrochemicals.

Top photo: Using a rotary weeder, Ms. Sugunamma of Warangal district in Andra Prahesh, India, removes weeds and aerates the top soil of her field. Above photos: Growing rice under aerobic conditions leads to larger and healthier roots (inset photo) and more productive plants than rice grown under continuously flooded conditions.

What farmers say about SRI

Higher Productivity, Lower Production Costs

For example, one conventional plant produces 5 panicles [fertile tillers], one SRI plant produces 8-10 panicles. Each conventional panicle contains 100-120 full grains while each SRI panicle has 180-200 full grains. Surely, SRI is a winner. It rightly responds to the pressures of high input costs and low margins in this tough business where many farmers have suffered. They heavily applied chemical fertilizers, thus, soil becomes unfertile. The overuse and abuse of herbicide spray makes the rice plants become unhealthy and more susceptible to diseases and less productive.

— Mr. Le Ngoc Thach, president of Dai Nghia cooperative, Vietnam. Mr. Thach is one of the first SRI farmers in Ha Noi province. After only four crop seasons, the entire cooperative paddy land of 175 hectares [432 acres] is managed with SRI practices.

Motivated Communities

In the beginning, people who didn't participate in the SRI test treated us like fools; now they regret not having learned the techniques for themselves. I would like to see all 120 farmers who share this irrigation perimeter using SRI, allowing us to cut the water pumping costs considerably. We five SRI farmers can help to teach the others.

— Farmer Mossa Ag Alhousseini of Bagadadji village, Timbuktu region, one of the first SRI farmers in Mali.

Improved Household Food Security

After adopting SRI methods in half an acre [.20 hectare] from the 1.6 acres [.65 hectare] of my land, I found that I not only needed less amount of seed and water, but one woman laborer was enough to complete the transplantation. I got more paddy when compared to the earlier years, and one and a half times more green fodder. This means, from this year on I can ensure that my family eats more food while saving on some of the costs of cultivation.

— Damayanthi Devi, Barmanu ki Sher, Sirmour, Himachal Pradesh. Ms. Devi was given technical training and support in the SRI methods by People's Science Institute, funded by the WWF-ICRISAT.

What policymakers say about SRI

UNTAPPED POTENTIAL

We now have a degree of experience in SRI application in Vietnam. It is evident that SRI increases economic returns and has potential to adapt to climate change. Both researchers and farmers need to work together to explore this potential.

— Dr Bui Ba Bong, Vice-minister, Ministry of Agriculture and Rural Development, recorded in the meeting with Janet McKinley, Chairperson, Board of Oxfam America, September 2009

ECONOMICALLY VIABLE

SRI is a productive set of practices, each proven, which can individually contribute to plant growth and development. SRI trials in Africa have shown that the yield potential of existing rice varieties can be doubled, without increasing agrochemical inputs and with saving of water. This is economically viable and environment-friendly.

— Dr Mustapha Ceesay, Assistant Director General in charge of Research and Development, National Agricultural Research Institute, Gambia

MORE CROP PER DROP

Everyone cites India's Green Revolution. But I'm even more intrigued by what is known as SRI, or system of rice intensification, and I know this is also an area of interest for Prime Minister Manmohan Singh. Using smart water management and planting practices, farmers in Tamil Nadu have increased rice yields between 30% and 80%, reduced water use by 30%, and now require significantly less fertilizer. This emerging technology not only addresses food security, but also the water scarcity challenge that climate change is making all the more dangerous. These are all lessons for our world.

— World Bank President Robert Zoellick, *Hindustan Times,* December 2, 2009

A BOON TO FARMERS

Because of the rice intensification scheme, [Tamil Nadu state's] production touched 64.61 lakh tonnes. While in the normal cultivation, 3,450 kg of rice could be produced per hectare, under the intensification scheme, it is somewhere between 6,000 and 9,000 kg. These advanced technologies will make farming in the State a highly remunerative one.

— Tamil Nadu State Agriculture Minister Veerapandi S. Arumugam *The Hindu,* December 1, 2009

Mei Xie, Senior Water Resources Specialist, World Bank Institute, tries out a weeder in a SRI field during a 2009 visit to the World Bank IAMWARM project in Tamil Nadu.

Tamil Nadu has the second highest paddy productivity after Punjab state, but is one of India's driest states with per capita water availability of only 900 cubic meters a year, less than half the country's average. Agriculture consumes 75% of the state's water. In 2006, with World Bank credit, the state implemented a five-year project to improve agricultural water management, covering 63 river basins in Tamil Nadu. The Irrigated Agriculture Modernization and Waterbodies Restoration and Maintenance (IAMWARM) project is extending SRI to 250,000 hectares, both for purposes of water saving and agricultural productivity. Farmers are given training, inputs, tools (weeder and marker), technical assistance and monitoring to implement SRI. During the main season of 2009, failure of the monsoon rains set back agricultural production in many parts of India. Tamil Nadu's Minister of Agriculture credits farmers' ability to achieve higher yields with less water using SRI methods as enabling the state to raise its rice production, even though a smaller area was planted because of drought.

Relevance of SRI for climate change

Changes in climate will affect rice production and thus have an impact on food security. It has been estimated (IWMI 2007) that for every 1ºC rise in mean temperature, there is a corresponding 7% decline in rice yield. The International Food Policy Research Institute calculates a 12-14% decline in world rice production by 2050 due to the effects climate change (Nelson et al. 2009). Beyond increasing yields, SRI offers three major benefits that have significant climate implications if applied on a large-scale:

- Reduced demand for water
- Reduced methane gas emissions
- Reduced use of nitrogen fertilizers

In addition, with SRI practices, rice plants have stronger stems and root systems that are more resistant to flooding and storm damage compared to those grown using conventional practices. Perhaps even more important, their deeper root systems make crops more drought-resistant.

SRI METHODS REDUCE FRESHWATER REQUIREMENTS FOR RICE PRODUCTION

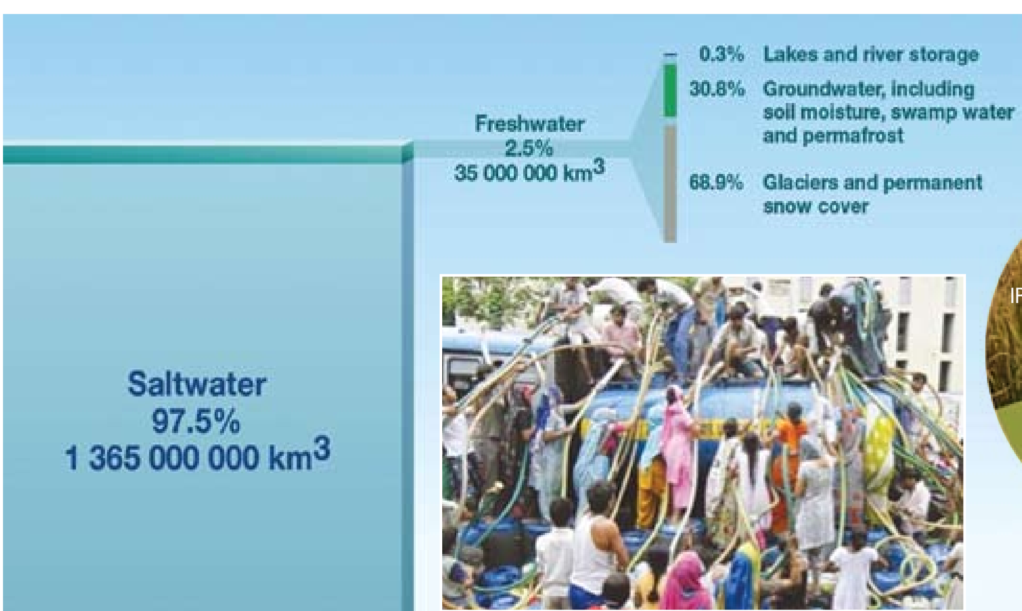
It is estimated that 24-30% of the world's accessible freshwater resources (rivers, lakes and aquifers) are used to irrigate rice (IWMI 2007). Worldwide, water scarcity is already a reality for as many as 2 billion people. Water for agriculture is becoming increasingly scarce, and climate change-induced higher temperatures will increase crops' water requirements, so shortages will become more serious. By 2025, 15–20 million of the world's 79 million hectares of irrigated rice lowlands, which provide three-quarters of the world's rice supply, are expected to suffer some degree of water scarcity (IWMI 2007). It is also estimated that to eliminate hunger and undernourishment for the world's population by 2025, the additional water requirements may be equivalent to all freshwater withdrawn and used today for agricultural, industrial and domestic purposes (SIWI 2005). Ways must be found to increase water use efficiency in both irrigated and rain fed agriculture.

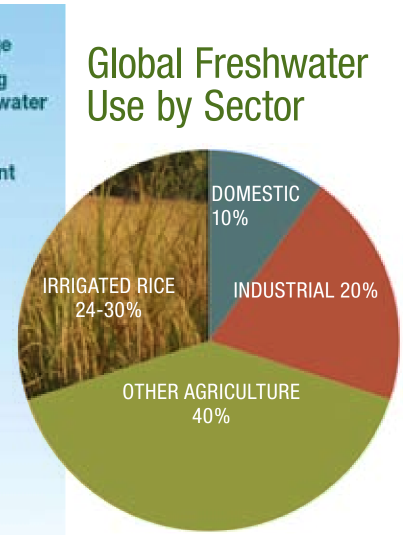
SRI's lower water requirements also mean that farmers can continue to grow rice in regions experiencing diminishing water availability.

With SRI methods, water use for irrigated paddy cultivation is reduced by 25-50%. Using less water for rice production can free up water for other crops, promoting crop diversification, and for other sectors such as domestic, industrial and environmental uses. SRI's lower water requirements also mean that farmers can continue to grow rice in regions experiencing diminishing water availability.

SRI REDUCES METHANE GAS EMISSIONS

Of the three main greenhouse gases—carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)—most attention has so far focused on CO_2 emissions because the volumes involved are the largest. However, molecule for molecule, methane has 23-25 times more and nitrous oxide 310 times more impact on warming of the atmosphere than CO_2. According to U.C.





Source: Data from IWMI (2007) and WRI (2005).

Source: Igor A. Shiklomanov, State Hydrological Institute (St. Petersburg) and UNESCO, Paris, 1999. In: Vital Water Graphics 2. UNEP/GRID-Arendal.

A Scarce Resource: Freshwater resources are just 2.5% of the total volume of water on earth, and only a small fraction of that is available for human use. Most water is used for agriculture to irrigate crops, especially rice. It takes three to five times more water to grow rice than wheat or corn. As competition for water increases (see inset photo of urban water delivery in India), SRI methods are a promising opportunity to reduce demand for water from agriculture so it can be used for other domestic and environmental purposes.

Berkeley scientist, Kirk Smith, one ton of methane emitted today will exert more warming effect until 2075 than a ton of CO_2 emitted at the same time' (see sidebar).

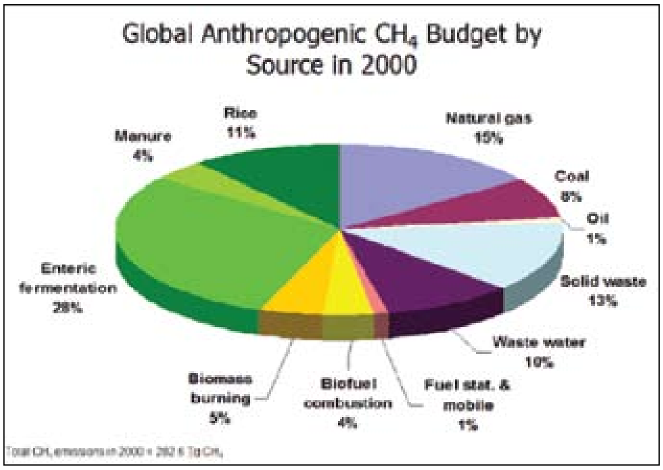
Methane released from agricultural activities largely comes from inundated rice fields and ruminant animals, which together produce almost half of human-induced methane. Methane is produced by anaerobic microbes in soils that are deprived of oxygen by continuous flooding. Making paddy soils intermittently and mostly aerobic substantially reduces methane emissions (Nguyen et al. 2007). One study by the China Academy of Sciences calculated that methane emissions would be reduced by almost one-third annually if all of the continuously flooded rice fields were drained at least once during the growing season and rice straw was returned to the soil in the off season (Yan et al. 2009). SRI practices recommend draining of paddy fields several times during the growing season.

Field studies at the Bogor Agricultural University in Indonesia have confirmed that SRI methods significantly reduce methane emissions. Evaluations of the greenhouse gas effects of SRI management with organic fertilization have found little or no increase in nitrous oxide emissions in the various SRI field trials (Iswandi 2008). The Chinese study cited above concluded that with reduced flooding and return of rice straw to the soil, gains from methane reduction would not be offset by increased nitrous oxide. The Tamil Nadu Agriculture University in India is also studying the reduction of methane gas emissions from SRI fields as compared to other rice cultivation practices.

TACKLING METHANE YIELDS IMMEDIATE BENEFITS

"... less than half of the total warming expected over the next 20 years will be caused by carbon dioxide (CO_2). Methane, along with other gases such as carbon monoxide, volatile organic compounds (VOCs) and black carbon particles, will cause most of the changes. Recent modelling shows the way to have the biggest impact on warming over this century is to immediately reduce emission of these gases, and keep them low. ...The global health burden from these air pollutants exceeds that of any other environmental risk and even that of some major diseases, including malaria and TB. Cutting methane emissions and those of other health damaging greenhouse pollutants would thus save many lives. This fruit is low-hanging, ripe and heavy with immediate benefits."

— Kirk Smith, Professor, Global Environmental Health, University of California, Berkeley
New Scientist, June 25, 2009



Source: US Environmental Protection Agency

Converting irrigated rice production to SRI-like methods represents a promising, low-cost strategy to reduce global methane emissions.

... nitrogen fertilizer is "the third major threat to our planet, after biodiversity loss and climate change."
— John Lawton, former Chief Executive, Natural Environment Research Council, UK

SRI CAN REDUCE NITROGEN FERTILIZER USE

Modern agriculture depends on manufactured synthetic fertilizers to sustain crop yields, especially inorganic nitrogen (N) fertilizers. The use of N fertilizers has increased almost 20-fold over the last 50 years (Glass 2003), becoming a major contributor of N_2O emissions and also to nitric acid, which causes acid rain. About half of all N fertilizer is used in maize, rice, and wheat production, with about 16% applied to rice. Only 30-50% of N fertilizer applied to crops is actually taken up by them, and when applied under flooded conditions, losses into the environment can be as high as 60% (Ghosh and Bhat 1998). High levels of nitrogen pollute drinking water sources with nitrate accumulations and can harm fish and marine ecosystems.

If current trends continue, the demand for inorganic fertilizers is projected to increase by 65% by 2050, which would result in a doubling of nitrogen released into the atmosphere and waterways (Rashid et al. 2005). Former chief executive of the Natural Environment Research Council in the UK, John Lawton, has characterized the rising use of nitrogen fertilizer as "the third major threat to our planet, after biodiversity loss and climate change" (Giles 2005).

By applying organic matter to improve soil texture and the soil biota, and by improving nutrient use efficiency (Zhao et al. 2009), farmers are able to reduce their N fertilizer use and costs with SRI methods. While nitrogen from organic inputs can also contribute to greenhouse gas emissions, most manufactured N fertilizers, derived from petroleum products, contribute indirectly to greenhouse gas emissions during production and transportation and they have no long-term positive effect on soil quality. Organic inputs obtained locally, on the other hand, have little or no production or transportation costs and improve the soil's productive capacity for the long term.

Oxfam has been facilitating the use of fertilizer briquettes that are placed deep in the soil, and there is less loss of nutrients from rice paddies into connected rivers and lakes. Whether SRI practices are either fully organic or combine organic and inorganic N sources, both result in reduced overall GHG emissions associated with overuse, manufacturing and long-distance transport of chemical fertilizers.

Experiences with SRI: Country Reports from Mali, Vietnam, India

INTRODUCTION TO THE COUNTRY REPORTS

Whether in India, Mali or Vietnam, the smallholder farmers around the world with whom we work and who represent the majority of the world's poor people, confront similar challenges. These include small landholdings, reduced profitability due to yields that do not cover the rising costs of seeds and agrochemicals, mounting debt, not enough or erratic supply of water, overused soils, crop failures due to extreme weather and pests, poor access to markets and information, and inefficient or overuse of inputs.

It is in this context of seeking solutions to improve the well-being of vulnerable rural families that many international NGOs and civil society organizations have come to investigate SRI. Africare, Oxfam, and WWF are at different stages of experience in working with SRI practice, evaluation and promotion. Africare began SRI on-farm trials in the Timbuktu region of Mali in 2007. In February 2010 the first national-level meeting on SRI in Mali was organized presenting results from three projects working in five out of eight regions in Mali with 450 farmers. Oxfam has supported SRI experimentation and extension in the Mekong region since 2003, reaching over 264,000 farmers in Vietnam and over 100,000 in Cambodia, while WWF has been involved in evaluation and promotion of SRI principles in India since 2004, seeing these methods reach over 600,000 smallholder farmers in the subcontinent through a variety of civil society, government, university, community and private sector initiatives.

The country reports compiled here represent just part of the SRI story and only part of our organizations' work with SRI. SRI activities are supported by Oxfam throughout Southeast and South Asia. WWF supports SRI activities in India extensively and in Morocco and Tanzania on a much smaller scale. In India, WWF is also spearheading the adaptation of SRI methods to other "thirsty" crops like sugarcane and wheat.

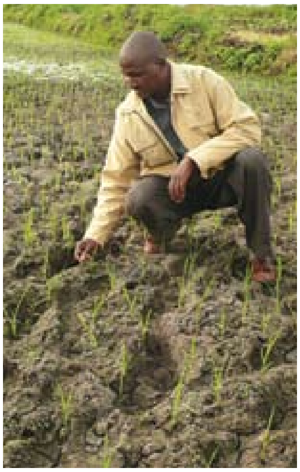
However, these country profiles demonstrate the diversity of social and agroecological settings in which SRI has been introduced, the benefits, constraints, approaches taken, and extension strategies that have emerged. In all cases, we and our national institutional partners have worked closely and extensively with farmers so we have firsthand knowledge of SRI's positive effects on farmers and communities.

A MENU OF OPTIONS

What these country profiles clearly illustrate is that SRI is not a conventional "technology." Rather than a "recipe," it is more a "menu" of options for improving the productive efficiency of land, labor, water, nutrients and capital. Results are best when all steps are followed, as there is a synergistic effect, but farmers have the choice of adopting all or any of the options as they see fit and as their circumstances allow. Whichever steps they implement, farmers see immediate visible improvements that motivate them and make self-extension work. As a consequence, what is "intensified" is knowledge, skill and management from farmers rather than the amount of inputs applied.

Results are thus understandably not uniform across countries or even sometimes on neighboring fields. They will vary according to soil, climate, local constraints, which steps a farmer applies and the quality of management. This is why some farmers triple their usual yields and others achieve only a 20% increase initially. Generally, the more confident and skilled a farmer becomes, the better the crop performance.

While there was initially some controversy among rice scientists about SRI reports, this has subsided as scientific studies evaluating the effects of SRI methods have begun getting pub-



SRI practices have been validated in 40 countries and many diverse rice-growing environments. From left to right: Rio Grande do Sul in southern Brazil; China National Rice Research Institute demonstrations in Zhejiang Province; and first SRI farmer from Mwea irrigation scheme in Kenya.

lished in the international, peer-reviewed literature, and as SRI has started being promoted by government agencies in the major rice-producing countries—China, India, Indonesia, Cambodia and Vietnam—based on their own evaluations and experience.

The significance of SRI lies not only in enabling farmers to increase yields with less water, but in the basket of associated social and environmental benefits.

There may still be some disagreement whether SRI methods can outperform what scientists consider "best management practices" as results are not always consistent. But SRI should not be compared with costly, high-input agricultural methods since these are mostly beyond the reach of poor households, who need to get the most productivity from their limited land, labor, capital and water.

IMPROVED FARM HOUSEHOLD RESILIENCE AND ADAPTABILITY TO CLIMATE CHANGE

The significance of SRI lies not only in enabling farmers to increase yields with less water, but in the basket of associated social and environmental benefits. As noted, the methodology is flexible. Farmers can introduce steps incrementally depending on their circumstances and as they gain skill and knowledge. The methods work with any variety of rice and on any farm size, from subsistence farms to larger scale operations. However, the methods were developed for and are particularly suited to the needs of resource-limited households, reliant on small landholdings. Thus, SRI methods are fundamentally "pro-poor."

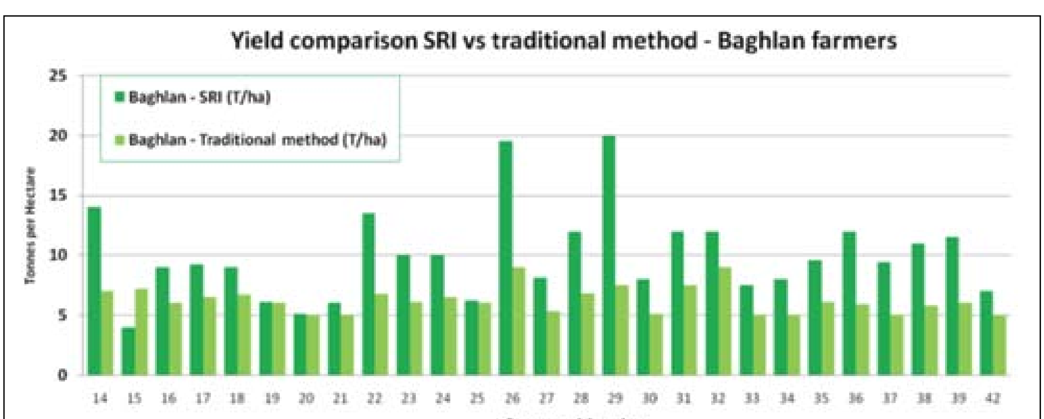
These farm households, with few savings and few options, are under greatest pressure to maintain their meager incomes and least equipped to cope with the volatility of input prices or rebound when crops fail or livestock die. SRI methods and benefits give these farmers a suite of strategies to manage their risks and the capacity of their households and farming systems to recover from setbacks. This will be especially important as temperature and weather abnormalities are expected to become increasingly common in the decades ahead. These strategies, reported from our field programs in Cambodia and Vietnam, India and Mali, and observed as well in other countries, are summarized on page 14.

REQUIREMENTS AND COSTS

SRI is very much a work in progress, and farmer innovation is paramount. Practices such as timing and spacing, water management, pest control and fertilization options are always to be adapted to local conditions and cropping systems. While SRI ideas and practices can be adapted to a wide range of conditions and cropping systems, farmers can encounter constraints, as with the introduction of any new technology or innovation. These include not having good water control and drainage, labor availability especially during the learning phase, sometimes vulnerability of very young seedlings, not enough biomass or organic matter to fertilize fields, access to implements such as weeders and markers, and farmers' apprehension about changing age-old practices or those recommended by official extension programs. Some constraints can be altered by further learning and practicing or access to implements, while others will require supportive institutional or policy environments for SRI to scale up to a landscape or basin level.

Initially, SRI steps can require more labor—mainly for preparing land and weeding. Most farmers using SRI have found that as they acquire skill in the methods, their efficiency of work improves, and SRI actually becomes labor-saving. In Cambodia and Vietnam, for example, SRI's labor-saving during the transplanting phase is regarded by women, who are the region's primary farmers, as one of its chief merits. Good SRI extension promotes farmer initiative and evaluation. It encourages farmers to take more responsibility for adaptation and innovation, contributing to human resource development in rural areas and the prospect of farmers being better able to identify and exploit other innovations as they emerge.

For readers interested in learning more about SRI activities in other countries, related research, and the science that underpins SRI principles, a list of articles and other resources is provided in the Annex.



SRI methods have been effective in areas where communities are recovering from conflict and natural disasters. In northern Afghanistan, the Aga Khan Foundation has been introducing SRI methods under difficult conditions. In on-farm comparison results for 27 farmers in 2009 almost all farmers increased their yields substantially (Thomas and Ramzi 2009).

SRI Improves Farm Household Resilience and Climate Change Adaptability

Reported and Validated Benefits	Contribution to Resilience and Climate Change Adaptability
Higher yields per unit of land, labor and capital invested	Grain yields are increased on average by 20-50%, but often more. This not only generates more food, but releases some land and labor for other productive activities. Higher productivity per unit of land reduces pressure to expand cultivated area at the expense of other ecosystems.
Lightened workload for women	Women farmers widely report that SRI methods save them time and reduce the drudgery of rice cultivation, due to less time for nursery management and transplanting, ease of working with smaller seedlings, and less time laboring in standing water. It frees their time for activities of their choice (such as vegetable growing for profit or improved family diet) and enables other family members to seek non-farm employment, thereby diversifying household income.
Reduced requirements for irrigation water	With SRI, irrigation water use is generally reduced by 25-50%, as water is managed to maintain mostly aerobic soil conditions. Farmers can continue to cultivate rice where water is becoming scarcer or rains unpredictable, and can mitigate losses from late monsoons or less rainfall. Less water used at the head of canals means more water is available for farmers at the end. Water can be freed up for other crops and people, and for the maintenance of natural ecosystems.
Reduced seed rate	Since farmers need 80-90% fewer seeds for transplanting, they need much less space to sow the seed nurseries. Flooded nurseries are planted with a seed rate of 50-75 kg/ha whereas SRI nurseries are planted with a seed rate of only 5-7 kg/ha, leaving farmers more rice to use for food rather than planting. Smaller nurseries are easier to manage and require a lot less land.
Reduced reliance on chemical fertilizers, herbicides, and pesticides	The high and rising cost of fertilizer and other inputs is one of the main attractions for farmers to use SRI as it allows them to reduce chemical applications without loss of yield. Fewer chemicals around farmsteads has health benefits for people and their livestock. Reduced chemical loads and better soil and water quality has beneficial effects throughout the environment.
Resistance to lodging and storm damage (possibly also cold spells)	Climate change is contributing to more frequent and more severe storms, which cause rice plants to fall over or lodge. This can be devastating to farmers. A fallen crop is vulnerable to rotting and also more difficult to harvest. SRI practices produce stronger straw (tillers) and larger, deeper root systems that make rice plants less susceptible to being blown down or pushed over.
Increased resistance to pest damage	Climate change is expected to increase the prevalence and distribution of pest species as temperatures and rainfall patterns change. With SRI management, farmers observe less loss to pests and diseases even though they use fewer agrochemicals.
Increased drought tolerance	SRI rice plants exhibit stronger root systems that grow deeper into the soil profile. At greater depth they can access deeper reserves of soil moisture (and nutrients). This is particularly important given the increasing risk of rainfall variation during the growing season.
Shorter growing season	SRI crops can often be harvested 1-2 weeks, even sometimes 3 weeks earlier than the same variety conventionally grown. This has economic and environmental advantages. Farmers can use the same field for a short-season crop like a vegetable, or can plant a following crop such as wheat sooner to get higher yield. A shorter growing period reduces water needs and the crop's exposure to pests and storms that arrive late in the season.
Fewer seeds and faster time to planting give more flexibility	If a farmer's crop succumbs to adverse weather patterns, farmers can more easily find the seeds and time to replant the nursery and replant the crop since SRI requires only one-tenth of the seeds, and seedlings can be planted within 8-15 days of sowing, rather than 30-45. People who must travel after planting to find paid work can do so much sooner, and if they have to return to replant a failed crop, they only have to come home for a short time.
Increased production and marketing potential from traditional varieties keeps them viable	With SRI methods, farmers are able to achieve higher yields from their traditional varieties, most of which are better adapted genetically to a range of climate stresses. These local varieties often command a better price in the market. Rice biodiversity has plummeted since the 1960s; however, studies show many traditional varieties offer higher iron and protein content. Rehabilitation and conservation of landraces and local cultivars can give more genetic diversity for dealing with adverse growing conditions, maintaining robustness in the systems.
Improved farmer knowledge, experimentation and innovation	Good SRI extension promotes farmer initiative and evaluation. It encourages farmers to take more responsibility for adaptation and innovation, contributing to human resource development in rural areas and the prospect of farmers being able to identify and exploit other innovations as they emerge.
Diversified cropping systems	With higher yields per unit of paddy land, some farmers convert part of their land to growing more nutritional and more profitable crops such as fruits, vegetables, legumes and small livestock that diversify their diets and raise incomes. Reductions in chemical use make farming systems more compatible with fish, ducks and other non-crop components. More diversification of cropping systems helps to restore biodiversity and sequester carbon in the soil.

SRI reduces the drudgery of growing rice for women. Working with smaller nurseries, smaller and fewer seedlings, and time-saving tools, frees their time for other activities. It also eliminates the need to stand or crouch for hours in flooded fields, which can lead to women's health problems.

The stronger, deeper root systems of SRI plants make them better able to withstand high winds and storms. These are fields in Dông Trù village north of Hanoi, after a typhoon passed over: SRI fields are on the left and conventional crop is on the right.

SRI crops can often be harvested several weeks earlier than the same variety conventionally grown. In Mali, plants in the SRI plot (on the right) are clearly more advanced than the plot of conventionally grown rice (on the left). The rice is the same variety and was planted the same day in the nursery. A shorter crop cycle offers several advantages: it requires less irrigation, thus reducing water use and the cost of pumping water; it means a shorter time to harvest; and it may allow farmers to switch to more productive longer cycle varieties.

Using SRI, many farmers are able to obtain higher premiums in domestic and export markets for their surplus rice, especially for traditional varieties, thus promoting the conservation of rice biodiversity. Lotus Foods, a company in California, is importing rice from SRI farmers in Cambodia, Indonesia and Madagascar. Above, Lotus Foods co-president, Ken Lee, inspects rice in Cambodia; SRI rice from Indonesia certified Fair for Life*; and the launch of SRI rices at the Natural Expo West trade show 2009.*

SRI stimulates farmer innovation and small enterprise development. This is an example of an innovation in mechanical weeders, built to weed two rows at a time, and adjustable to accommodate more or less space between rows.

Africare

AFRICARE'S EXPERIENCE WITH SRI IN MALI

Africare has been engaged in Mali since 1973, working with village populations to increase food production and rural incomes, improve health and nutrition, and manage natural resources—especially water.

Since 1997, efforts have focused on implementing an integrated food security program in the Timbuktu region. This arid region on the edge of the Sahara Desert is one of the most food-insecure areas in Mali. Annual rainfall is only 150-200 millimeters, so agricultural production depends on the annual rise of the Niger river and seasonal flooding of river branches, ponds and lakes. Traditionally, farmers use this annual flooding to practice either recessional agriculture as the flooding subsides, or deepwater rice cultivation during the flooding itself. The extent of the flooding determines the amount of land cultivated each year, which is highly variable, and becoming increasingly so, making agriculture production uncertain. Yields are usually very low, less than one ton per hectare for both rice and sorghum.

Rice is of strategic importance in the region and the entire country. It is increasingly favored by consumers in urban zones—at the expense of sorghum and millet—and also in the rural areas where it is produced. Per capita annual consumption has tripled in the last 20 years, from 34 kg to 94 kg per person. Fueling the increase has been the expansion of irrigated areas, which enable farmers to achieve much higher yields of 4-6 tons/ha.

Africare has worked with farmers to establish village-based, small-scale irrigation schemes of about 30-35 hectares each that can be irrigated by one diesel motor pump. However, since 80-100 farmers share the land under irrigation in such schemes, the average irrigated crop area available per household is only about one-third of a hectare. Getting maximum yields and maximum efficiency of inputs, including water, from these small landholdings is essential for reducing poverty.

INTRODUCTION OF SRI

The Goundam Food Security Initiative, implemented by Africare with funding from USAID, undertook a first test of SRI in 2007, to assess its performance compared to current rice farming practices in the Timbuktu region and potential for impact on food security.

Africare technicians determined which of the SRI principles and steps could be readily tested, and the Imam of the village of Douegoussou, an important community leader and farmer, offered to do the first trial on his own land, committing labor and all inputs. The steps of transplanting young seedlings, one plant per hill, on a 25 centimeter-square grid, and applying organic matter produced a yield of 9.0 tons/ha compared to the "best practices" control plot of 6.7 tons/ha.

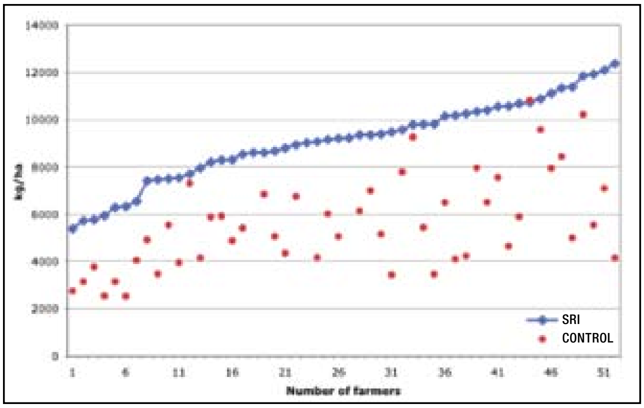
APPROACH: FARMERS TAKE OWNERSHIP

Based on these positive results, the Better U Foundation (BUF) gave a grant to Africare to assess the performance of SRI more extensively during the 2008-09 growing season to:

- Obtain information on the performance of SRI in various field settings of the region;
- Create a general awareness about SRI in the rice-growing areas of Timbuktu; and
- Determine potential for promotion of SRI more widely in the region and in Mali.

Africare selected 12 villages in the Dire and Goundam administrative circles with which it has collaborated over the past 5-10 years, and with diverse geographic coverage. All 12 villages decided by consensus to participate, and each supported five volunteer farmers to work on SRI evaluation. The area under rice cultivation in the 12 villages is more than 1,900 hectares—roughly more than 10% of the entire area of irrigated rice in the Timbuktu region—and includes approximately 17,200 rice-producing households.

In traditional nurseries (top left) women sit in the water for hours at a time to pull out seedlings from the ground, an unpleasant and unhealthy task. The roots are washed in the water, and all soil is removed before bundling them and carrying them to the field. SRI seedlings (right) are lifted up gently from their nursery with a hoe, and transporting them to the field for planting is 'child's play.'



Average yields for the SRI plots were 66% higher than the average for control plots (see figure). Although SRI plots used 3.5-5 times fewer plants at the time of transplanting, the 1-plant SRI pockets produced an average of 50% more tillers than the 3-plant pockets in the control plots, and at harvest the number of panicles per square meter was 31% higher than in the control plots. SRI farmer Bouba Boureima from Morikoira village holds up plants from one control plot pocket of 3-4 plants (left) and one SRI plant (right).

Africare supplied each village with two rotary weeders (a simple tool previously unknown in the region) and provided close technical support, with one field agent for every 15 farmers to guide them on how to apply the SRI steps. The government agent in charge of agricultural production based in Goundam made sure that the data were properly collected. The volunteer farmers visited each other's fields, and received visitors from outside their communities who wanted to learn about SRI. They also participated in evaluations organized by Africare to develop recommendations and a training manual for SRI.

The farmers were free to choose their own plot size, rice variety, fertilizer, and had to provide all the supplies themselves. The rice nurseries for the SRI and control plots (each 400 square meters on average) were sown with the same seed on the same day. SRI seedlings were transplanted 10-12 days after germination, one per planting pocket. In the control plots, seedlings were transplanted on average at 29 days after germination with two to five seedlings in each pocket. Because of the predetermined water distribution in the irrigation scheme, water control and thus water savings were not optimal.

The government agriculture service recommends applying 200 kg/ha for urea. SRI farmers were recommended to apply chemical fertilizer only if absolutely necessary, and to use as little as possible. All SRI farmers applied organic manure and reduced the amount of urea to an average of 120 kg/ha, compared to 145 kg/ha in the control plots.

FINDINGS - HIGHER YIELDS, HIGHER NET INCOMES

The yield improvement and economic advantage of SRI compared to control plots was significant across all 12 villages. Actual performance varied according to soil types, rice varieties, fertilizer regimes and weeding practices. Average SRI yield for the 53 farmers who used the practices as recommended was 9.1 tons/ha, 66% higher than the average for control plots at 5.5 tons/ha. The average yield on neighboring rice fields where non-participating farmers used their own methods was 4.86 tons/ha.

Per hectare input costs were slightly higher for SRI. This was due to somewhat higher labor costs for land preparation and transplanting, and for the estimated cost of manure. Most SRI farmers did not pay for the manure, but collected and transported it to the fields themselves; it was assigned a cost based on prices reported by the villagers. Because SRI revenues were 2.1 higher than from the control plots, profitability was much increased. At prevailing market prices, net revenue for SRI farmers would equal more than 1 million CFA/ha (equivalent to $2,220 USD/ha) compared to 490,000 CFA/ha (equivalent to $1,089 USD/ha) for the control plots (see table on page 18.)

Farmers were enthusiastic about SRI, listing many advantages: increased yields; reduced seed use; less weeding time (when using the hand weeder); and better and faster plant development. Under SRI, only 6 kg/ha of seed was required compared to 40-60 kg/ha for the control. And with the application of organic matter, synthetic fertilizer inputs were reduced by 30%. SRI plots could also be harvested 10-15 days prior to the control plots. This could allow farmers to beat the onset of the cold season and to switch from lower yielding short-cycle varieties to higher-yielding medium-duration varieties like BG90-2. Farmers in Adina, Niambourgou and Donghoi villages all confronted a cold spell toward the end of the cropping season. Whereas SRI plants were already in the grain-filling stage, panicles had not yet emerged in the control plots. Add to this, in Niambourgou and Donghoi, flocks of birds, which migrate into the region towards the end of the season, caused great damage to the rice crop still standing in the field.

The yield improvement and economic advantage of SRI compared to control plots was significant across all 12 villages.

Overall, farmers did not find disadvantages with SRI, although they mentioned constraints, most having to do with increased labor needed for good land preparation and learning how to transplant. It is fully expected that farmers will reduce their planting time considerably once they become more skilled at handling the small seedlings and planting in a grid pattern.

LESSONS LEARNED

In Mali, SRI results have surprised practically every technician and every farmer. Many of the guidelines for SRI contradict those from research institutes and the technical service, and even clash with what farmers currently think works best. For instance, farmers in Mali believe that using more water to inundate their rice fields will give more yields, and extension personnel as well as farmers are convinced that larger applications of synthetic fertilizer will give better results. Future extension will have to address this thinking.

Production costs, production value and net revenue for SRI, control and farmer practice plots (per/ha)

	Quantities			Costs in CFA (%)		
INPUTS	SRI	Control	FP	SRI	Control	FP
Irrigation (gas, oil)	90%	100%	100%	99,000 (21)	110,000 (27)	110,000 (29)
Capital costs of pump	90%	100%	100%	40,500 (8)	45,000 (11)	45,000 (12)
Seeds (kg)	6	50	50	2,280 (0.5)	19,000 (5)	19,000 (5)
Urea (kg)	120	145	97	42,000 (9)	50,750 (12)	33,950 (9)
DAP (kg)	8	34	20	2,800 (0.5)	11,900 (3)	7,000 (2)
Manure (tons)	13	3	0	39,000 (8)	9,000 (2)	0
Labor (person days)*	251	169	161	251,000 (53)	169,000 (41)	161,000 (43)
Total input costs				**476,580 (100)**	**414,650 (100)**	**375,950 (100)**
PRODUCTION (per ha)	**9.1 tons**	**5.49 tons**	**4.86 tons**	**1,501,500 CFA**	**905,850 CFA**	**801,900 CFA**
NET REVENUE (per ha)				**1,024.920 CFA**	**491,200 CFA**	**425,950 CFA**
Production cost per kg of paddy				52 CFA	76 CFA	77 CFA
Input cost as % of production value				32%	46%	47%

FP = Farmer practice, less input-intensive than the Control plots, which were considered 'best practice'
* Land preparation: SRI - 40% tractor, 60% hand; Control - 33% tractor, 15% hand, 52% no-till, Farmer practice - 20% tractor, 80% no-till.
Note: SRI practices were still unfamiliar in this first season; farmers agreed that their SRI labor inputs should become less in subsequent seasons.

The farmers participated in the SRI evaluation on a completely voluntary basis. They committed their own inputs. This is contrary to the more common practice of providing free seed and fertilizer as incentive when conducting trials. With farmers responsible for their crop management, the results directly reflected farmers' conditions and realities. Once exposed to SRI ideas and results via good quality extension and participation in measurement, farmers and technicians started to be more open to new ideas, to be more wide-ranging in their observations, and to rethink current practices.

High-quality technical backstopping is essential to ensure farmers fully understand the principles and are confident afterwards to make adjustments. Technicians must have solid training to provide that caliber of backstopping. The production and dissemination of good technical support materials is an important part of this, as is good data collection (done *with* rather than for farmers) to inform their decisions as well as those of extension, research and policy.

Training should explicitly include both men and women as women are often limited by tradition to certain rice production operations. One of the most rewarding parts of the 2009 evaluation was seeing a women's production group take over all phases of rice production for themselves and achieve very good results (see opposite: Women in Findoukaina Take to SRI).

To further adapt SRI practices to local conditions in Mali, and improve technical feasibility for farmers to expand the area under SRI, the most important adaptations to pursue are:

i) Investigate systems for production of quality biomass needed for organic fertilization. This includes on-site compost pits using rice straw, animal manure, and other organic matter (plant biomass of all sorts) as components. Where it is used, techniques for applying synthetic fertilizer should be improved, especially for urea. For example, incorporating urea into the soil during rotary weeding will preserve the nutrients better than the current practice of broadcasting urea into the irrigation water, which is linked to significant nutrient losses.

ii) Improve field preparation techniques by testing and introducing small machinery for tilling and leveling;

iii) Evaluate the application of SRI steps on other crops and rice varieties such as traditional African rice (*Oryza glaberrima*) and new researcher-bred strains such as NERICA varieties;

iv) Experiment with different irrigation regimes to generate reliable technical recommendations for the Timbuktu region and elsewhere in Mali.

NEXT STEPS

Within three years to 2009, and with the support of BUF and USAID, Africare has helped 300 farmers start working with SRI in Timbuktu. In 2009 the USAID-funded project IICEM (Initiatives Integrées pour la Croissance Economique au Mali) started introducing SRI into four additional regions. The Syngenta Foundation for Sustainable Agriculture is supporting Mali's agricultural research organization, Institut d'Economie Rurale du Mali, to introduce SRI into the country's main irrigated rice production zone, the Office du Niger.

There are few material requirements for SRI utilization, and no great cost beyond locally specific research, coordinated extension, and the opportunity for local innovation.

The challenge ahead is to design and deliver on a scale that will allow farmers across the nation to be introduced to SRI methods. The prospect is that SRI as a knowledge-based methodology could spread quickly and be adopted by most rice farmers in Mali if they received consistent and quality technical assistance and extension. There are few material requirements for SRI utilization, and no great cost beyond locally specific research, coordinated extension, and the opportunity for local innovation.

The impact on food security could be significant for farmers adopting SRI and for Mali as a country. Mali is among the main rice producers in West Africa. Malian farmers are already starting to extend SRI concepts and techniques to other crops, in particular wheat. SRI could help Malian farmers achieve rice self-sufficiency without expensive subventions or subsidization of fertilizers and seeds, as provided currently by the Malian Government's "Rice Initiative." Mali could become an exporter of rice and play a stabilizing role for food security in the sub-region.

Women preparing and planting their SRI plot (above). Maya Abdoulaye and Maya Hama proudly showing their plots to the male SRI farmers from Morikoira and Findoukaina villages during a farmer visit to Findoukaina (bottom left). Maya Abdoulaye (bottom right) shown here in her second season using SRI practices.

Women in Findoukaina Take to SRI

In the north of Mali, rice is considered a man's crop. Women do not cultivate rice on their own. Only a few of the more tedious tasks are done by women such as removing seedlings from the nurseries, weeding, and threshing.

Working with Africare over the past five years, a women's group in the village of Findoukaina has obtained a diesel motor water pump, which members use to irrigate their market vegetable gardens during the cool season. During the rice-growing season, the women use their pump only to earn some additional money by pumping water for the male rice farmers, but do not have any fields of their own.

During village meetings to identify farmers wishing to take part in the SRI tests, we encouraged women to participate, even though we knew that women do not usually plant rice. To our surprise, the village of Findoukaina selected two members of the women's' group, Maya Abdoulaye and Maya Hama, to participate in the SRI trials.

Like all the women in Findoukaina, neither of them had ever grown rice before. But they were helped by all 20 members of the women's group to establish and manage the SRI plots, closely following the technical advice from the Africare field agent. They did all the work themselves—plowing, field leveling, and planting—with no help from the men.

After having shown their SRI plots to a group of visiting farmers, as the group started to leave the village, the women of Findoukaina began singing and dancing to show their excitement and pride in their work. Maya Abdoulaye added: "This year, we learned about SRI. Next year, all 20 group members will plant their own SRI fields."

[Note: Despite the very late arrival of water in the 2009-2010 season, over half of the women in the cooperative planted their own rice fields using SRI practices, including Maya Abdoulaye.]

OXFAM'S EXPERIENCE WITH SRI IN VIETNAM

Oxfam has been working in the Mekong region of Southeast Asia for over 30 years, including 20 years in Vietnam. Although Vietnam's economy is strengthening, inequality between the rich and poor is sharply on the rise, and millions of Vietnam's ethnic minorities and rural communities remain in poverty.

Since the transition from central planning to a market-oriented economy in the early 1980s, the agricultural sector has usually grown faster than 4% per annum, fueled by a vibrant rice sector. Total annual paddy (unmilled) rice production grew from 19.2 million tons in 1990 to 35.8 million tons in 2005. Vietnam is now one of the most-productive rice-growing countries in the world with national yields over 5 tons/ha from each of two crops per year.

Over 9 million rural households in Vietnam, of which 95% live in the Northern region, own less than 0.5 hectare of paddy land, which is usually fragmented into smaller plots. These small-scale farmers face volatility in prices for agricultural inputs, which eat into net incomes. They are not benefitting from the increasing food prices. Meanwhile, the limited agricultural extension services that are available seldom reach the small farms.

For rice production in Vietnam in general, and in the Northern Delta in particular, there is a problem of overuse of chemical (especially nitrogen) fertilizer, pesticides, and seed. The high application of nitrogen and high transplanting density have become major reasons for rice crops' vulnerability to pests and disease, adversely affecting yield, economic efficiency, and the health of environments and communities (Dung 2007).

Half of Vietnam's rice production area is irrigated, and limitations in water supply are increasingly becoming a constraint. According to the UNDP, per capita water availability is now just one-third of what it was in 1945, and competition for water resources is growing rapidly.

INTRODUCTION OF SRI

At a time when small farmers are under pressure from many directions—with increasing cost of inputs that are often over-applied, competition for land resources, climate change, and scarcity of water resources—SRI offers welcome opportunities.

Vietnam's Ministry of Agriculture and Rural Development (MARD) Plant Protection Department (PPD) learned about SRI in 2002, from Integrated Pest Management (IPM) colleagues in Indonesia, who had been working with CIIFAD [Cornell International Institute for Food, Agriculture and Development] at Cornell University to assess SRI methods in that country. PPD began conducting SRI training in 2003 in three provinces within the context of its own national IPM Program, supported by the FAO. This training effort was extended to five provinces in 2004 and to 12 in 2005 on a larger scale, ranging from 2-5 hectares for each site. In 2006, SRI was extended to 17 provinces, with the participation of 3,450 farmers, by Vietnam's IPM Program and by the Biodiversity, Use and Conservation in Asia Program (BUCAP), supported by FAO and DANIDA.

In its report to MARD on the outcome of the SRI evaluations from 2003-2006, the national IPM Program concluded that SRI could play an important role in the sustainable development of irrigated rice cultivation in Vietnam. It recommended that "SRI should be disseminated further and widely, allowing many more farmers to benefit from this new innovation. ...The healthier crop leads to good resistance against pests and to a significant reduction of pesticide use in the field." Average yields increased by 9-15% in comparison to farmers' current practices, while using 70-90% less seed, 20-25% less nitrogen fertilizer, and one-third less water.

> **"SRI should be disseminated further and widely, allowing many more farmers to benefit from this new technology."**

In late 2006, Oxfam began collaborating with PPD in Ha Noi (formerly Ha Tay province), to set up some initial SRI work. Provincial leaders were receptive to innovation. This was followed by a study tour to visit their Cambodian counterparts to learn about and observe successes, challenges and opportunities of SRI work supported by Oxfam in that country. This culminated in their investment in the SRI scaling-up going forward today.

APPROACH

Oxfam's Community-based SRI Model

The strategy in Vietnam consists of trials, demonstrations, and dissemination. This involves raising farmers' awareness and capacity to apply SRI principles and steps, demonstrating the advantages to local producers and government bodies, and formulating appropriate, replicable extension to bring SRI knowledge to farmers across the country.

Ultimately, the goal is to enhance farmers' confidence and their capacity for adopting new techniques in rice cultivation so that they can address agricultural and community problems with appropriate technical backstopping and thus control their own development.

In 2007, with Oxfam funding, the then Ha Tay Plant Protection Sub-Department (PPSD) in cooperation with the agro-cooperative of Dai Nghia Commune carried out community-based SRI activities involving local authorities, farmers, women and youth unions, and the farming community. Field trials implemented with the agro-cooperative assessed relationships among transplanting rates, water regulation, various fertilizer applications, and the performance of established rice varieties under SRI management. At the same time these trials were used for training farmers and technicians. They in turn organized Farmer Field Schools (FFS) in their communities and set up trial plots. FFS is a participatory, season-long experiential learning approach involving farmer-led experiments, regular field observations and group analysis, with guidance from technical staff. The knowledge gained from these activities enables participants to make their own locally-specific informed decisions about crop management practices.

Leaders of Ha Noi province inspecting SRI plants: (left) Director of PPD, Mr. Nguyen Duy Hong; (center) People's Committee Vice-chair, Mr. Trinh Duy Hung; and (right) Director of Agriculture and Rural Development Department, Mr. Chu Van Thuong.

Through this community-based strategy, over 1,000 farmers were reached. Net profit from SRI fields increased on average by more than 2 million VND/ha (about $125 USD).

In October 2007, at the recommendation of the PPD and in response to the success of the Oxfam-supported SRI demonstration and extension activities in Ha Noi and results in other provinces, the Minister of Agriculture officially acknowledged SRI as a technical advancement and paved the way for broader local-level application of SRI, with provincial governments able to access central government funding to support SRI extension.

The provincial authorities subsequently took the lead in Ha Noi province and used their budget resources to scale up the application of SRI in the next year to 33,000 hectares with 108,000 farmers. Within one year, farmers were utilizing the SRI steps on 18% of the province's total paddy area.

Phase 2: Building on Early Success

Having made a strong start in Ha Noi province, Oxfam launched a three-year, multi-province, multi-partner SRI program in Vietnam, involving PPD, the Centre for Sustainable Rural Development (SRD), Oxfam (Quebec), and Hanoi University of Agriculture. SRI promotion and training is being carried out in 13 communes in six northern provinces, namely Ha Noi, Yen Bai, Phu Tho, Thai Nguyen, Ha Tinh and Nghe An. At the same time the National IPM Program and BUCAP independently organized Farmer Field Schools, demonstration sites, and training activities in several central provinces. SRI was tried on small field sites on different types of soil and with several preferred rice varieties. These trials aimed to train farmers to become expert farmer-teachers able to act as local extension agents. By encouraging these farmers to take the lead in innovation and experimentation and to guide the learning process, the program built confidence and capacity at the local level, especially among rural women, who make up 76% of the program's key farmers.

FFS plots were carefully monitored and documented, with attention given to issues beyond agronomy, including: gender impacts; income generation; and knowledge transfer. Consistent collection and analysis of such data contributed to program refinement and replication by partners and local governments.

To raise awareness of SRI principles and of sustainable agriculture in general, the program has conducted community-level workshops for farmers and local officials, as well as training-of-trainers as extension agents. Further, the program has prioritized the development of print and multimedia communication tools for use in its community-level awareness-raising activities.

FINDINGS - MORE RESILIENT RURAL HOUSEHOLDS

After two harvests in these six provinces, a clear pattern of positive results emerged. A statistical review of the 2008 season in program areas showed average SRI yields of 6.3 tons/ha through FFSs, 11% higher than for currently accepted practices across the province. While these gains are not as great as in most other countries where SRI has been used, there are other benefits to be considered, which are important to farmers. These production increases have been achieved with approximately 16% less urea

Preparing seedlings for transplanting. The smaller, compact and more manageable SRI seed nurseries save on seed, land and labor. During the spring season crop of 2009, when SRI methods were applied to about 85,000 hectares, an estimated 2,500 tons of rice seed were saved.

In Vietnam, Oxfam's strategy consists of trials, demonstrations and dissemination carried out with national and local authorities and communities. Here, a spacing trial serves not only to train farmers in SRI practices but generates important data about how best to adapt SRI to local conditions.

fertilizer. The frequency of pesticide applications has gone down by 45%, and average irrigation expenses have been reduced by 35%. This combination of input savings and output gains contributed to income increases of approximately 50%, or roughly 5.4 million VDN ($315 USD) /ha /season.

The increase in yields is attributed in part to increased natural pest resistance for rice plants grown under SRI management. In general it has been observed that rice crops grown using the SRI steps reduce farmers' risks and improve their resilience in uncertain conditions. Storms of increasing frequency and intensity are being reported, notably in northern Vietnam. Heavy rains and strong winds often result in lodging (collapse of the crop canopy), which can be devastating to farmers. A lodged crop is vulnerable to rotting, and farmers are often compelled to salvage whatever they can (even if it is only straw) as quickly as they can. SRI crops with their stronger tillers and stronger, deeper root systems are less susceptible to lodging.

More vigorous root systems are also able to draw on soil moisture and nutrients at lower levels in the soil to better withstand the stress of drought and limited soil fertility. In the event that the crop succumbs to adverse weather, SRI gives farmers the option of replanting quickly because fewer seeds are needed, less time is required to grow suitable seedlings, and less labor is necessary for the replanting.

LESSONS LEARNED

The SRI initiative in Vietnam has been successful due to a number of reasons:

- The program responds to key gaps in the current extension services, namely, farmer's confidence and capability, and ways of working between farmers and local officials/extension staff.
- National government endorsement is a great advantage to legitimacy and promotion of SRI.
- The program is a multi-partner collaboration that includes government agencies, international and national NGOs, universities, and local institutions. All partners have been involved from very early stages of the program development, resulting in a high level of shared understanding of program goals and approaches, and a high level of commitment, synergy and effective collaboration.
- The evidence-based, open-ended learning approaches promoted through FFS are well received by both farmers and local officials. Farmers' own findings through SRI pilot projects and experiments and their messages are powerful in scaling up and getting political support.
- Data collection and analysis are reinforced by collaboration with national academic institutions, which in turn give weight to advocacy messages.
- Communication strategies involving mass media are effective for raising wider awareness of SRI and for further scaling up program impacts, as shown in the case of Ha Noi province.

The Oxfam program in Vietnam intends to support expansion of SRI into additional areas.

NEXT STEPS

On the national level, the SRI steps are now being applied fully or partially by over 264,000 farmers in 21 provinces on approximately 85,422 hectares, resulting in a savings of 2,500 tons of rice seed, 1,700 tons of urea fertilizer, and an increase in income of 170 billion VND per crop season. SRI extension has been limited so far to the northern and central regions of Vietnam, and has not yet taken hold in the Mekong Delta.

The potential for broader SRI application is large. MARD already has an ongoing campaign for sustainable agriculture, known as the "3 Reductions and 3 Gains," whose recommendations are consistent with SRI steps: reduction of seed, fertilizer, and pesticide inputs to achieve improvements in productivity, rice quality, and profitability. In many areas, SRI steps are already being incorporated into this campaign.

Over the next few years, the Oxfam program in Vietnam intends to support expansion of SRI into additional areas, and to intensify its application where already established. Oxfam is engaged with national institutions in carrying out locally relevant research. This includes rates of SRI adoption, obstacles to SRI adoption, and cost-benefit analysis of SRI using household-level bookkeeping. Findings from these studies will feed into policymaking processes and will help refine extension messages to rice farmers faced with diverse growing conditions and resource constraints.

On average, each woman from an SRI Farmer Field School promotes 5-8 other farmers to adopt SRI while the rate is only 1-3 for male graduates. Top: FFS graduates in Dông Trù village, Hanoi province, undertake SRI training village to village carrying with them examples of "regular" and SRI rice plants. Left: Ethnic woman farmer enthusiastically shares her SRI experience with the agricultural technicians and Cambodian counterparts during the second SRI National Workshop in January 2010.

GENDER DIMENSIONS OF SRI ADOPTION IN VIETNAM

In Vietnam, and elsewhere in the region, the recent trend is for women over 40 years old to be the primary rice farmers. Historically, men and women share many of the tasks in rice farming. Men generally perform land preparation tasks, while seedling preparation, transplanting, and weeding are assigned to women. Harvesting is a shared task. Given Vietnam's increasing integration into the world economy, non-village based and non-farm employment is becoming a more critical source of income. This inevitably reconfigures the distribution of workloads and decision-making processes in rural households. A recent study in 2010 about SRI adoption in Vietnam, commissioned by Oxfam, revealed that women actively engage in SRI application. About 70% of Farmer Field School (FFS) participants are female farmers. Women are often the first member in the family to be receptive to SRI.

In surveys carried out in areas of Ha Noi, Ninh Binh and Yen Bai provinces with high incidence of SRI adoption, female adopters reported that immediate savings due to SRI's lower production costs help them ease the pressure from short-term credit needs and cover expenses for children. The tangible economic benefits from SRI give women a greater voice in their families. Both female and male adopters cited that more manual weeding and thorough land preparation are challenges to SRI farming. Painstaking weeding without any mechanized or simple device makes farmers reluctant to discontinue herbicide spray. Heavier land preparation also disadvantages some female-headed households if they have reduced access to male labor or lack suitable mechanized support.

The surveys noted that female adopters would like to have better materials on SRI. Women also complained that their demands for and ideas to improve water management and land preparation are not well listened to due to the perception that they do not have sufficient knowledge on these matters.

Despite these challenges, women's uptake of SRI has been remarkable. On average, a female graduate from a SRI FFS often promotes 5-8 other farmers to adopt SRI while the rate is only 1-3 for male graduates. The key difference is that women are more likely to exchange labor and support each other in critical steps of SRI farming such as seedbed preparation, transplanting, and team discussion. The labor exchange normally starts with a small group of relatives, and then extends to neighbors and farmers whose land parcels are in the same place.

Abstracted from: Nguyen Xuan Nguyen et al. (January 2010). Study on adoption of the System of Rice Intensification in Northern provinces of Vietnam. A report by commissioned by Oxfam America.

WWF'S EXPERIENCE WITH SRI IN INDIA

As a conservation organization, WWF has long been concerned about humankind's footprint on the environment. Farming, particularly irrigated agriculture, consumes the largest volume of the planet's freshwater resources.

Having identified rice, sugar, cotton and wheat as the world's four most water-intensive crops, WWF has made it a priority to find ways to improve the productivity of these four crops with respect to their land and water inputs. The goal is to reduce mounting pressure on freshwater ecosystems, help protect vital biodiversity, and improve food production.

Since 2003, WWF has been participating in a global multi-stakeholder, cross-sectoral "Dialogue on Food, Water and the Environment," with a programmatic partnership with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) headquartered in Andhra Pradesh, India. The immediate impetus was to find alternatives to the costly water infrastructure schemes and major dams being proposed by the Government of Andhra Pradesh to increase agricultural production.

While India is increasingly seen as an urbanizing and industrializing country, 70% of the country's population are farmers; 80% of those farmers have less than one hectare of land. India has the world's largest area devoted to rice cultivation, and it is the second largest producer of rice after China. Over half of its rice area is irrigated, contributing 75% of the total production, but also consuming 50-60% of the nation's finite freshwater resources. India's population is projected to grow from 1.15 billion inhabitants to 1.6 billion in 2050, putting tremendous strain on its land and water resources. This makes rice production in India a key target for WWF intervention.

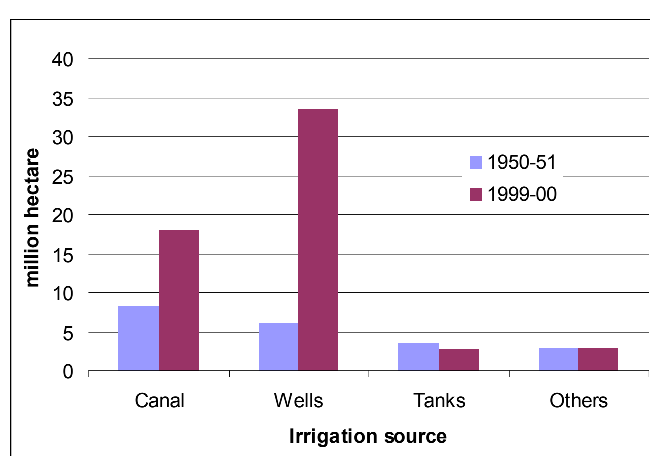
Wells in India must be dug deeper and deeper as the water table falls. This dry open well is a clear example of severe depletion of water tables.

In the past, increases in paddy production have come primarily from increases in productivity rather than area. Productivity increases were achieved through the introduction and spread of farming methods that included more intensive use of water and high-yielding varieties and hybrids, accompanied by greater application of synthetic fertilizers, pesticides, fungicides and herbicides.

In 20 years about 60% of all aquifers in India will be in a critical condition. There is an urgent need to change the *status quo*.

India's post-independence agricultural growth involved huge investments in irrigation projects that resulted in more than a tripling in the gross irrigated area from 22.6 million hectares (1950-51) to 76.3 million hectares (1999-00). With population growth, this has contributed to a drastic reduction in per capita freshwater availability during that period.

As seen in the figure below, the greatest growth of irrigation has been through the installation of wells. In some regions, over-exploitation of groundwater supplies through pump extraction is leading to serious declines in groundwater levels. India is the largest user of groundwater in the world (over a quarter of the global total); 60% of irrigated agriculture and 85% of drinking water supplies are dependent on groundwater. According to the World Bank, if current trends continue, in 20 years about 60% of all aquifers in India will be in a



Source: More Rice with Less Water (WWF 2008).

critical condition. This will have serious implications for the sustainability of agriculture, long-term food security, livelihoods, and economic growth. It is estimated that over a quarter of the country's harvest will be at risk. There is an urgent need to change the *status quo*.

Despite significant and steady intensification of fertilizer and pesticide use on farmers' fields, national yields and production of irrigated rice have not altered much since the 1990s and even declined in some areas. Annual fertilizer sales to Indian farmers went from 338,000 tons in 1961 to 8 million tons in 1985 and to 20.6 million tons in 2005. Soil structure and fertility have been adversely affected by over-irrigation and heavy chemical applications, leading to soil salinization, compaction and other limitations on productivity. When soil and water resources are oversupplied with fertilizers and pesticides, this can have adverse affects on wetlands and wildlife habitats, human health, and non-targeted plants and insects.

India needs to increase rice production by about 2.5 million tons a year in order to meet its requirements in 2050—an almost 92% increase on its current production. Diverting yet more water for agriculture from rivers and underground aquifers that diminishes water available for drinking, sanitation and maintenance of critical natural systems is not a viable option. India has to adopt methods like SRI.

INTRODUCTION OF SRI

SRI was introduced in India in 2000 when researchers at the Tamil Nadu Agricultural University (TNAU) initiated experiments involving SRI principles in a collaborative project on growing rice with less water. TNAU results in 2000-02 were followed by evaluations on farmers' fields. In 2003 a package of SRI practices was evolved and tested in 200 farmers' fields through a state government initiative to compare the performance of SRI and conventional cultivation in the Cauvery and Tamiraparani river basins. The results showed an average increase in grain yield by 1.5 tons/ha in both basins with reduced input requirements, and even an 8% reduction in labor needed per hectare. This evaluation provided a basis for officially recommending SRI adoption to farmers in 2004.

Concurrently, the state agricultural university in Andhra Pradesh, Acharya N.G. Ranga Agricultural University (ANGRAU), introduced SRI in farmers' fields during *Kharif* season 2003, after ANGRAU scientists saw SRI being implemented in Sri Lanka. Comparison trials were conducted in all districts of the state. These results generated nationwide interest as they showed average yield increases of 2.5 tons/ha, 50% over conventional irrigated rice cultivation.

WWF AND SRI

Impressed by the SRI results of TNAU and ANGRAU, the WWF-ICRISAT Joint Dialogue Project extended technical as well as financial support for a systematic evaluation of SRI methods by ANGRAU and the Centre for Rural Operations and Programmes Society, a local NGO, through on-farm field trials in 11 state districts over several years, starting with the *Rabi* season of 2004-05. The evaluation in its second year involved scientists at ICRISAT and in the Directorate of Rice Research of the Indian Council for Agricultural Research.

Based on the very positive results of these evaluations, in November 2005, WWF-ICRISAT approached the Government of Andhra Pradesh for scaling up adoption of SRI. The State Government responded positively and financed the establishment

The Late Dr. Y.S. Rajashekar Reddy (right), former Chief Minister of Andhra Pradesh state, with Minister for Agriculture Raghuveera Reddy (center), visiting SRI fields in Ranga Reddy district of Andhra Pradesh in 2005, organized by WWF-ICRISAT.

WWF-ICRISAT has supported SRI research, field trials and demonstrations, and farmer interaction workshops throughout India (top photo, demo sign in Tripura state). Above, Biksham Gujja, policy adviser in the WWF Global Freshwater Programme, discusses SRI with farmers and agricultural officers in Punjab state, one of India's most important rice-producing regions, with acute water shortages.

of SRI demonstration plots in all villages throughout the state, and a program was started for training farmers and staff members of the state's Agriculture Department. Over five years (2003-04 to 2007-08) and two seasons each year, the average yield increase from SRI demonstrations was 26.5% more than from conventional practices.

APPROACH: DEVELOPING A NATIONAL PLATFORM

By this time, NGOs, universities, government departments, and private-sector entities in other states were also beginning to evaluate and disseminate SRI elsewhere in India. WWF-ICRISAT began working with other interested institutions and individuals so the opportunities that SRI was showing could have greater national impact.

In particular, a myriad of local and regional civil society organizations (CSOs) around India were independently introducing SRI practices in rural communities. The role played by CSOs in promoting SRI across the country is an unprecedented one, especially in enhancing the livelihood of poor rice farmers in remote and tribal areas.

CSOs were joined by a variety of government agencies such as the Department of Agriculture in Tripura State; colleges and universities; institutions such as the Xavier Institute of Management in Bhubaneswar; private entities such as Tilda Ricelands Pvt. Ltd.; foundations such as the Sir Dorabji Tata Trust (SDTT); and banks such as the National Bank for Agricultural and Rural Development (NABARD). All brought different capabilities and approaches to the dissemination of SRI knowledge and opportunities.

WWF-ICRISAT recognized that without some coordination among these different entities and some framework for tracking and distilling SRI experience, bringing together the research and adoption taking place around the country, these efforts would be less effective than they could be. There would be no synthesis of what was being learned. Time and money could be wasted through duplicative efforts. WWF-ICRISAT thus took the initiative to develop a national platform based at ICRISAT to facilitate: 1) collaborative synergies among key stakeholders, namely national and state rice research institutes, agricultural universities, CSOs, municipal officials, and donors; 2) research and extension activities; 3) synthesis and sharing of information; and 4) dialogue among stakeholders from the farm level to national level.

Building Collaborative Synergies

Funded by the Ministry of Foreign Affairs, Norway, and WWF-Netherlands, WWF-ICRISAT Project activities have included research to generate scientific understanding of SRI principles, initiatives to support SRI introduction in different agro-climatic conditions, field trials and demonstrations, farmer to farmer interaction workshops, field-based resource centers, media events, capacity-building, and actively promoting and organizing interactions among farmers, scientists, government agencies, and CSOs for information sharing and problem solving. The project is also successfully applying similar principles in improving other crops such as sugarcane through the Sustainable Sugarcane Initiative (SSI). Key national partners include:

- Acharya N.G. Ranga Agricultural University (ANGRAU), Hyderabad
- Agriculture-Man-Ecology Foundation (AMEF), Bangalore
- Centre for Rural Operations and Programmes Society (CROPS), Jangaon, Andhra Pradesh
- Directorate of Rice Research (DRR), Hyderabad
- Peoples' Science Institute (PSI), Dehradun
- Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu (SKUAST-J), Chatha
- Vikas Sahyog Kendra (VSK), Jharkhand
- Watershed Support Services and Activities Network (WASSAN), Hyderabad.

The most visible and influential activities of WWF-ICRISAT have been the three national symposia. These symposia have facilitated cross-learning, supported the development of networks of interested individuals and groups, strengthened the efforts of farmer-innovators, and refined the research agenda by defining issues concerning SRI.

The first symposium at ANGRAU in 2006, brought together about 200 SRI researchers, farmers, promoters, practitioners, and policymakers from across the country. The Andhra Pradesh Minister of Agriculture presided over the opening. The second national symposium was held in 2007 in Tripura state, where the state government had devoted one-third of its agricultural budget for promoting SRI. Also collaborating were the state's Department of Agriculture; the Directorate of Rice Research, Hyderabad; the Central Rice Research Institute, Cuttack; the Directorate of Rice Development, Patna; NABARD; SDTT; and ANGRAU. The 2008 symposium was hosted by TNAU and included support from SDTT and NABARD.

In addition to hosting a national SRI website (www.sri-india.net) and producing—together with government, academic and NGO partners—SRI-related studies, reports, newsletters, man-

National SRI symposia have been key in promoting learning and policy dialogue about SRI in India (above). Below, Dr. V.V. Sadamate, Adviser, Planning Commission (Agriculture), Government of India (far left with hat) and Dr. V. Vinod Goud (next to him), Project Coordinator, WWF-ICRISAT, and District Agriculture officers visit SRI farmer fields in Warangal district, Andhra Pradesh.

Grain yields in SRI recorded in experiments across India

S.No.	Location	Grain Yield (tons/ha) Conventional	SRI	% increase /decrease	Source
1	Tamil Nadu Rice Research Institute, TNAU, Aduthurai	4.7	7.1	+ 48.9	Rajendran et.al., 2005
2	14 Research stations, ANGRAU, Andhra Pradesh	4.9	5.7	+ 16.6	Mallikarjuna Reddy et.al., 2007
3	Indira Gandhi Agricultural University, Raipur, Chattisgarh	5.9 (2006) 4.3 (2007)	6.6 5.1	+ 12.0 + 17.8	Shrikant Chitale et al., 2007
4	Agricultural Research Institute, Patna, Bihar	3.9	6.1	+ 55.1	Ajaykumar et. al., 2007
5	Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, Puduchery	2.2	3.7	+ 68.3	Sridevi and Chellamuthu, 2007
6	ICAR Research Complex, Umiam, Meghalaya	4.0 (2005) 4.7 (2006)	4.4 5.2	+ 9.3 + 10.2	Munda et.al., 2007
7	Central Rice Research Institute, Cuttack, Orissa	4.9 (2005) 5.6 (2006)	5.9 7.0	+ 20.4 + 25.0	Rao et.al., 2007
8	Regional Agricultural Research Station, Shillongani, Assam	3.1	4.5	+ 45.2	Bora and Dutta, 2007
9	Agricultural Research Station, UAS, Kathalagere, Karnataka	8.8 (2005) 9.1 (2006)	10.2 10.5	+ 15.9 + 15.4	Jayadeva et al., 2008
10	Main Rice Research Station, AAU, Nawagam, Gujarat	4.0 (2006) 4.7 (2007)	6.3 7.5	+ 35.9 + 37.1	Chauhan et al., 2008
11	Birsa Agricultural University, Ranchi, Jharkhand	4.3	5.0	+ 16.3	Singh et al., 2009

Source: More Rice with Less Water (WWF 2008).

uals, proceedings, fact sheets, and case history compendiums, WWF-ICRISAT organized a crucial national-level policy meeting in February 2009. The "SRI Scaling Up – Future Directions: Core Group Meeting" made several recommendations including: reframing the scope of SRI as practice; national, state and regional level interventions; pro-active R&D support; and institutional mechanisms and policy advocacy to promote SRI.

Policy Dialogue

Increasingly, policy dialogues facilitated by WWF-ICRISAT have moved from the district and state levels to the national level. SRI has been incorporated into India's National Food Security Mission (NFSM) as a strategy for raising rice production in over 130 food-insecure districts across India. In May 2009, an "Interactive Policy Dialogue on Upscaling SRI"—building on outcomes of the 2008 symposium as well as the Core Group Meeting—was held at ANGRAU. Around 50 delegates attended. The meeting focused on developing a national framework and timeline for scaling up SRI, and on scientific and technical issues for further improving SRI adoption, including design and production of better tools and implements, research on varietal responses to SRI, identifying suitability in different climatic zones, and capacity building for dissemination.

FINDINGS: SRI'S ADVANTAGES ACCELERATE NATIONAL ADOPTION

Today, SRI is known to all rice-growing states in India. It is estimated that as many as 600,000 farmers are growing their rice with all or most of the recommended SRI crop management practices on about 1 million hectares distributed across more than 300 of the country's 564 rice-growing districts. SRI is also being adapted to rainfed conditions.

This is probably the most rapid uptake of new agricultural practices seen in the country, making SRI a national phenomenon with very limited resources devoted to extension. Both on-farm and on-station evaluations across many states and diverse growing environments have shown clearly that SRI has the potential to improve yields while reducing water use, production costs, and chemical inputs. Data from SRI experiments across India show an increase in grain yield up to 68%. A few experimental results obtained across the country are presented in the table to the left.

As in the case of Mali and Vietnam, farmers see the main advantages of adopting SRI as considerable saving in seed, water saving up to 50%, improved soil health, and yield increases in the range of 20-30%. Additional benefits include shorter time to maturity, higher yield of polished rice when SRI paddy is milled, and resistance to drought and storm damage. The major constraints experienced by farmers are lack of trained labor, difficulties in planting young seedlings, water management in low-lying areas, and greater requirements for weeding.

In India, the significance of SRI is not limited to rice alone. Its core practices are applicable to other crops, such as sugarcane. WWF with ICRISAT recently launched a detailed manual on the *Sustainable Sugarcane Initiative (SSI): Improving Sugarcane Cultivation in India*. The initial results are excellent. Like SRI, SSI could have significant implications for the way that sugarcane is cultivated worldwide. Promising experiments are also underway on wheat, finger millet, mustard, sesame, and other crops in various states of India.

NEXT STEPS

Representatives from the WWF-ICRISAT Project, along with colleagues from partner organizations, are engaged in dialogues with government agencies at both the state and national level on how to support the adoption of SRI at a larger scale—preferably at the basin level. The project has already organized and participated in several dialogues to convince the Government of India to adopt a national target of converting at least 20% of irrigated rice fields to the SRI method by 2015. With SRI, farmers are not only producing more food but are contributing to the national economy and environmental well-being by: saving water (thereby reducing need for government expenditures on water infrastructure projects); reducing fertilizer use (reducing budget outlays for fertilizer subsidies and enhancing soil quality if replaced by organic soil management); and saving energy now used to pump water from bore wells. These contributions should be recognized and rewarded at the policy level. To promote SRI, the government need not increase spending, but merely redirect resources.

The WWF-ICRISAT Project is now focusing on: a) quantifying water requirements of the SRI methods; b) establishing scientific research with partner organizations to understand the soil nutrients and root biomass resulting in high yields; c) working with existing national programs related to agriculture and water management to promote SRI; d) providing the tools for training; e) supporting critical research by the CSOs in understanding the comparative advantages of SRI; f) promoting farmer-to-farmer exchanges; and g) organizing further national SRI symposia to bring all the stakeholders together.



Farmer Siddimallaiah with his SRI plants that made it through the drought of 2009. Top right photos: Rice plants that he cultivated according to normal practices, dependent on irrigation, struggle in the parched soils and dry up. Without the harvest from his SRI field, Siddimallaiah and his family would have faced the loss of their farm and livelihood.

SRI A BOON TO FARMERS AFFECTED BY DROUGHT

After regular monsoons for four consecutive years, in 2009 there was a complete lack of rainfall during the traditional monsoon months from June to August, which is when farmers dependent on rainfed cultivation sow their seeds. In normal years, Andhra Pradesh receives about 297 millimeters of rainfall up to July. In 2009, it received only 157 millimeters up to July. Groundwater levels dropped almost 2 meters from 9.33 meters in July 2008 to 11.09 meters in July 2009. The Jangaon Block in Warangal district of Andhra Pradesh was one of the areas worst hit by the drought, as it came on top of the already severe depletion of groundwater in this region. But some farmers in the district who are dependent on rice for their food had been trained on SRI methods.

One such farmer is 65-year old Siddimallaiah, who cultivates paddy on 2 acres [.8 hectare] of land. He decided to try out SRI methods in a small patch of his land and the rest he sowed as usual. When the rains did not arrive the second week of June as anticipated, his dream of ensuring his family's food supply and possibly selling some extra literally dried up with the transplanted saplings in his paddies. Siddimallaiah was entirely dependent on the rains, as his bore wells had all dried up. He did not have enough money to get a new one dug. Moreover, none of the farmers had been successful in getting water from digging new bore wells.

To make matters worse, the irrigation requirement in the conventional fields was greatly increased due to the deep cracks that opened on the field surface. Yet due to fluctuating power supply during the summer months, the availability of power and the force of water (from the irrigating pump) were hardly sufficient to inundate the rice fields.

The future for Siddimallaiah was bleak. He was too old to be given work as a laborer, either in his village or even if he were to migrate. His family of six were all dependent on the yield to sustain them through the year. He became increasingly desperate as he realized he would not be able to repay his debts, incurred for buying seeds, fertilizers and pesticides.

That was when he noticed that in the SRI part of his fields the plants were growing even with very little water. As the days went on, the contrast became more pronounced. The SRI rice continued to thrive with very little water while the conventional rice withered. When Siddimallaiah harvested his field, where normally he might expect 30 bags of paddy (70 kg each) from one acre [.4 hectares], he found that there was no grain at all. The plants had to be sold as fodder for livestock. However, despite the drought, the parcel sown under the SRI methods yielded 35 bags (70 kg each) of paddy.

Siddimallaiah's success with SRI has inspired hundreds of farmers to adopt SRI methods even in areas well beyond the initial training sites.

Recommendations

Given the importance of rice as a staple food and the huge irrigated area on which it is cultivated, the potential benefits of adopting SRI-type practices are enormous in countries around the world. Benefits are not limited to nutrition and food security in developing countries and for poor people; there appear also to be very important environmental advantages involved. These derive from the reduced requirements for irrigation water and consequently reduced emission of greenhouse gases—methane in particular—produced when fields are kept flooded. Equally important are the reductions reported on the use of agricultural chemicals (fertilizers and pesticides), which makes it possible to limit the pollution that affects health and the sustainability of the currently prevailing production systems.

Also important, SRI is a ready opportunity, not requiring major investments in infrastructure or research. Farm families can be eating more rice, and improving their incomes, within one to two cropping seasons. With only modest expenditures, SRI methods are effective in rapidly increasing production while reducing water and other inputs. Investments to support training and extension for SRI could be covered from a part of the savings from reducing present subsidies on fertilizers and electricity for pumping water.

To fully realize the benefits of SRI for people and for ecosystems, however, scale is important. By adopting SRI and methods like SRI on a large-scale, governments can save money by reducing their budget outlays for food imports, as well as on agricultural subsidies. They can avoid building expensive new water supply structures, and reduce the costs to society and individuals from water conflicts and environmental degradation.

The Indian Government, for example, has allocated $40 million USD (about $8/ha) for extension of SRI methods to 5 million hectares of rice-growing areas in targeted districts with high incidence of poverty under its National Food Security Mission (NFSM). Data from comparative on-farm trials by Tamil Nadu Agricultural University in the Tamiraparani river basin in 2004 found SRI methods raising net income from $242 USD per hectare to $519 USD. Even if total investment is three times higher, the benefit-cost ratio from SRI promotion would be more than 10:1.

It is our recommendation that all major rice-producing countries should promote adoption of SRI, with a goal of at least 25% of their current irrigated rice cultivation systems converted to SRI by 2025, with all new irrigation schemes designed to support SRI farming, having ability to provide smaller amounts of water to rice farmers reliably.

WHAT STAKEHOLDERS CAN DO

Reaching this target will require government institutions, aid agencies, research institutes, and civil society to work together so investments made on behalf of small farmers achieve best effect.

• **Governments of developing countries** should review the prospects offered by SRI and where possible adopt SRI into national development strategies and ensure supporting policy and budgetary measures, in close coordination with national agriculture and irrigation ministries and related research and extension departments, agricultural universities, and civil society organizations.

• **Bilateral and multilateral aid agencies** should significantly increase their investment, through aid or loans, in supporting farmers toward SRI and complementary technologies and practices. This includes mobilizing technical assistance for project design and implementation, and capacity building at all levels required for large-scale adoption of SRI, in partnership with public, NGO, and private sector partners.

• **National and international research organizations** should review, document, and validate results related to SRI in a coordinated manner, drawing on location-specific results. There is enormous complementarity between genetic and management approaches. So far SRI has proved effective for all kinds of different local and improved rice varieties that have been selected under the usual fully irrigated conditions. To exploit the SRI cultivation conditions further, scientists should start to select for varieties under the intermittent moisture regimes and low plant densities typical for SRI practices.

• **Oxfam, Africare, WWF, and the many other NGOs and CSOs** who promote SRI should continue to share experiences, learning, and competencies with others to support this shift in agriculture, perhaps through regional cooperative networks starting with the countries detailed in this paper.

• **Private sector partners** such as retailers, wholesalers, distributors and international food brands can accelerate conversion to SRI methodology by targeting their rice purchases, and designating, for example, that 10-25% should be SRI-grown. SRI-grown rice from several countries is already attracting a premium in national and international markets. Opportunities exist for small- and medium-sized enterprises for the production, marketing, and after-sales-service of hand weeders and other tools. The fertilizer industry should revisit products and recommendations for small-scale farmers using SRI methods.

KEY REQUIREMENTS

Programs that extend SRI cultivation methods on a large scale should consider the following challenges and opportunities.

Training and extension: With SRI, what is intensified is farmers' knowledge, skill, and management rather than the amount of inputs applied. Demonstrations, trainings, and extension facilities are thus a must. Participatory Farmer Field Schools have proven effective in introducing SRI practices. Extension strategies that empower communities and enable participants to make their own locally-specific informed crop management decisions are to be preferred over conventional top-down approaches. Further, these programs must be tailored to each culture and group within the community, including extension personnel, women, tenant farmers, agricultural laborers, landholders, and agricultural suppliers.

Extending SRI on a large scale can be accelerated by ensuring that training programs recognize the critical role of women (top); by developing water systems that can deliver smaller and more precise amounts of water (middle); and by ensuring farmers have access to weeders and other labor-saving tools (bottom left). Increased research is also essential, including the potential for SRI methods in other crops. In India, SRI methods applied to sugarcane (bottom right) through the WWF-ICRISAT Sustainable Sugarcane Initiative (SSI) are already leading to yield gains and water savings.

Irrigation and Water Management: For governments to maximize cost savings and efficiencies in national water use they will need to invest in better control over the delivery of irrigation water. This includes the design and management of water storages, canals, field channels and drains. It may also require institutional reforms and capacity building for staff to support more precise and timely water allocation and delivery.

Tools and Inputs: The rotary weeder is a crucial tool for optimizing plant productivity and enhancing the efficiency of inputs under SRI methods. No single weeder will be suitable for all soils and local conditions. Designing and making available the most suitable weeder and other labor-saving implements in adequate numbers to a particular location is important. Also important is improving access to adequate biomass and exploring new combinations of organic and synthetic fertilizers. This will improve soil health and reduce dependence on agricultural chemicals. The use of fertilizer tablets or briquettes are an example for increasing efficient application.

Research: Research is critical to exploit fully the many social and economic advantages of SRI-type practices, as agricultural research has focused resources largely on genetic improvement options over the past decades to the neglect of crop management options. Research should have farmers' participation as a major component. Some important research topics include:

- Adaptation of SRI to specific eco-regions, including plant spacings and configurations, fertilizers and soil health, and labor-saving implements.
- The resilience of cropping systems under SRI as compared with conventional practices due to greater genetic diversity.
- Long-term comparative studies on pest and disease development, especially soil-borne, as well as on soil health in general.
- Greenhouse gas emissions from rice crops under SRI management need to be measured reliably to determine the extent to which SRI farmers are contributing to GHG mitigation.
- Adaptation of SRI methods to other crops.

Health and Nutrition: SRI methods have important public health implications. They could become part of strategies to control malaria by reducing the amount of standing water. A review of experiences over the past 80 years with intermittent irrigation in the cultivation of rice has shown that this can reduce significantly the density of malaria vectors by curtailing their larval development (Keiser et al. 2002). In a number of Asian countries, especially Bangladesh, eating rice is a source of human exposure to arsenic, a toxic heavy metal linked to cancer and other diseases. Rice plants absorb arsenic that originates in water from contaminated wells used to irrigate rice fields. In a 2008 study (Xu et al.), scientists found that rice grown under aerobic conditions such as SRI contained 10 to 15 times lower arsenic levels than under flooded rice conditions. Studies also show many traditional varieties, which are usually favored by SRI farmers, contain higher levels of iron, protein, and critical micronutrients. These could be more widely exploited for consumers in both urban and rural areas (Frei and Becker 2005).

Benefits of adopting SRI

Benefits for Rural Households

- More rice to eat and sell from same area of land
- Higher incomes/lower costs
- Less use of water
- Reduced dependency on purchased inputs [seeds, fertilizer, pesticide]
- Enhanced natural resource base and genetic diversity for more robust farming systems
- Reduced risk and vulnerability

Improved farm family well-being

Benefits for Countries

- Improved food security
- Improved rural livelihoods
- Water freed up from rice sector for other crops, people, natural systems
- Budget savings on new water projects
- Budget savings on food imports, energy, and fertilizer subsidies
- Improved soil and water quality from reduced loads of synthetic fertilizer and pesticides
- Less vulnerability from genetic uniformity
- More resilient, productive rural communities

Improved public well-being

Potential Benefits for the Planet

- Less pressure to convert remaining forests and natural landscapes to agriculture
- Reduction in global poverty
- Enhanced ecosystem services involved in regulating water, soil, climate
- Reductions in GHG, especially methane
- Reduced environmental degradation
- Less loss of plant and animal biodiversity from soil and water pollution
- Reduced flashpoints for conflict over food, water, land

Improved planetary well-being

Annex

Summary of on-farm evaluations of impacts from SRI methods in eight countries

Country	(N)	Evaluation for/by:	Yield increase (%)	Water saving (%)	Reduction in costs per ha (%)	Increased income per ha (%)
BANGLADESH (2002-04)	1,073[#]	IRRI-BD/ BRAC, SAFE, Syngenta BD	24	NM	7	59
CAMBODIA (2004)	500*	GTZ	41	RF	56	74
(2004)	120**	CEDAC	105	50	44	89
CHINA: Sichuan (2004)	82*	CAU	29	44	7.4[a]	64
INDIA: Tamil Nadu (2004)	100[#]	TNAU	28	45	11	112
Andhra Pradesh (2003-04)	1,535[#]	ANGRAU	38	40	NM	NM
West Bengal (2004)	108[#]	IWMI-India	32[b]	RF	35	67
INDONESIA (2002-06)	12,112[#]	Nippon Koei	78	40	20	100+
NEPAL (2005)	412[#]	DADO†	82	43	2.2[c]	163
SRI LANKA (2004)	120*	IWMI-SL	44	24	12	104
VIETNAM (2007-08)	‡	National IPM Program	17 (13-29)	33	30	23 (8-32)
Total	**16,162**		**47**	**40**	**23**	**68+**

(N): Number of farmers

NM: Not measured

RF: Rainfed SRI, where there were no irrigation facilities.

* Based on random samples.

[#] Results are from all cases using SRI methods covered in evaluation, no sampling.

** Results of NGO study of 120 farmers who had 3 years of experience with SRI methods as of 2004.

‡ Results from Farmer Field School trials in 13 districts across Vietnam, with 1,274 farmers participating; total number of SRI farmers in these districts in 2008 was 96,544, according to records of the Ministry of Agriculture and Rural Development's National IPM Program.

† Morang District Agricultural Development Office, Government of Nepal.

[a] Government extension personnel were promoting purchase of modern seeds and fertilizer simultaneously with SRI methods.

[b] One of the two villages studied experienced severe drought in the 2004 season.

[c] Labor-saving hand weeders were not yet available to reduce labor inputs and costs.

Sources: Listed in Uphoff (2007). Increasing water saving while raising rice yields with the System of Rice Intensification, in *Science, Technology and Trade for Peace and Prosperity: Proceedings of the 26th International Rice Congress, 9-12 October, 2006, New Delhi,* eds. P.K. Aggrawal et al., pp. 353-365. International Rice Research Institute, Los Baños, Philippines; plus Sato and Uphoff (2007), Dung (2007), and Dung and Minh (2008).

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Other Organizations Supporting SRI

The following is a partial list of international NGOs, foundations and donor agencies that have also contributed to the evaluation and dissemination of SRI in different countries:

Adventist Development and Relief Association (Cambodia, Indonesia, Madagascar)

Aga Khan Foundation (Afghanistan, Madagascar)

American Friends Service Committee (DPRK)

Better U Foundation (Madagascar, Mali)

CARE (Bangladesh)

CARITAS-Czech Republic (Indonesia)

Catholic Relief Services (CRS) (Madagascar)

Department for International Development, UK (DFID) (Nepal)

Educational Concerns for Hunger Organizations (ECHO) (Thailand)

European Union (Afghanistan, Cambodia)

Groupe de Recherche et d'Échanges Technologiques (GRET) (Myanmar)

German Agency for Technical Cooperation (GTZ) (Cambodia)

International Centre for Integrated Mountain Development (ICIMOD) (Nepal, Pakistan)

International Development Research Centre (IDRC) (Panama)

International Fund for Agricultural Development (IFAD) (Rwanda)

International Institute for Rural Reconstruction (Philippines)

International Organization of Migration (Iraq)

Japan Overseas Volunteer Corps (Laos, Vietnam)

LDS Charities (Cambodia)

Lions Club International (Madagascar-Ambatondrazaka)

MercyCorps (Sri Lanka)

Nippon Koei (Indonesia, Laos)

Oxfam (Bangladesh, Cambodia, Laos, Philippines, Sri Lanka, Vietnam)

Pro-Net 21 (Laos)

Rotary International (France-Lille, Indonesia-Ubud)

Sir Dorabji Tata Trust (India)

Syngenta Foundation for Sustainable Agriculture (India, Mali)

The Asia Foundation (DPRK)

U.S. Agency for International Development (Sierra Leone)

U.S. Peace Corps (Madagascar)

Vredeseilanden (VECO) (Indonesia, Vietnam)

World Bank (India/Tamil Nadu)

World Bank Institute (Kenya, Thailand)

World Education (Indonesia)

World Vision (Sierra Leone, Sri Lanka, Vietnam)

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MORE RICE FOR PEOPLE
MORE WATER FOR THE PLANET

System of Rice Intensification (SRI)

Contributing to Food Security, Farmers' Adaptability to Climate Change, and Environmental Sustainability

Africare Oxfam WWF