REPORT ON A VISIT TO INDIA AND BANGLADESH REGARDING SRI PROGRESS: February 17-26, 2005 – Norman Uphoff, CIIFAD

HIGHLIGHTS OF VISIT: Details given in the report

1. **TOP YIELDS:** The very high yields reported with SRI methods from some rice farms in Madagascar have continued to be a 'bone of contention' for persons who are skeptical about SRI. However, similar results are now being seen in India when SRI practices are used very well. This past season, the Andhra Pradesh Department of Extension measured an average paddy yield of **17.25 t/ha from 9 acres** (3.6 ha) where S. Lakshmana Reddy used SRI methods in Ramavaram, East Godavari. This was not calculated from a sample. One of Reddy's plots averaged 20 t/ha; however, the Department reported officially only the average yield for the whole extent (page 9).

Meanwhile, in Purulia, West Bengal, a rainfed area where holdings are small and the soil poor, Lakshmi Kant had a **rainfed paddy yield of 15 t/ha** with SRI. The field area was measured personally by the leader of the IWMI team that was studying SRI in Purulia, and he weighed the harvest himself; this was not a sample estimate, so he is certain of this. Another farmer there averaged **9 t/ha, also from rainfed paddy** (page 20). These results confirm that the potential that can be evoked from rice genotypes when proper growing conditions are provided to plants, associated apparently with the services of soil biota. We continue to hope that more rice scientists will join in assessing such results, rather than dismiss them on *a priori* grounds.

2. LARGE-SCALE PRODUCTION POSSIBLE: SRI is sometimes discounted as being productive only on small holdings and thus not relevant to meeting global food needs This is contradicted, however, by the success of N.V.R.K. Raju at his **100-acre farm** (40 hectares) in Kuruillagudam in West Godavari. Raju planted this whole area under five varieties with SRI in the 2003-04 rabi season, and got an average harvested yield of **11.15 t/ha**. Few farmers have as much land or as much organizational skill as Raju, a very successful poultry businessman. But this performance shows that SRI is a versatile innovation. Other farmers in Andhra Pradesh are now using SRI methods on 15-30 acre (6-10 ha) extents with good results (pages 9-10).

3. AVERAGE YIELD INCREASES AND PROFITABILITY: SRI is performing well in states where rice production is already quite advanced with 'modern' methods. SRI yields measured by the Andhra Pradesh Department of Extension from 476 on-farm comparison trials in kharif season 2003-04 distributed all across that state averaged **2.44 t/ha higher** than standard, very production methods -- 7.92 vs. 5.48 t/ha. In the preceding 2003-04 rabi season, 94 on-farm trials showed a similar **2.54 t/ha yield advantage** with SRI -- 9.67 vs. 7.13 t/ha. Since the average yield in AP is 3.87 t/ha, the farmers who did the trials were already producing at much higher than average levels (page 26).

In Tamil Nadu state, the Tamil Nadu Agricultural University has been doing on-farm comparison trials in the Tamiraparani basin as well as the Cauvery delta. The 100 trials monitored by TNAU in Tamiraparani last kharif season showed a **1.5 t/ha yield differential favoring SRI** -- 7.2 vs. 5.7 t/ha (pages 22-23). These results and others from Andhra Pradesh are suggesting that SRI methods give better results where soils are well-drained throughout the year.

Note that these yield gains are being achieved with lower costs of production (lower by 11% in the TNAU trials) and with reduced use of water (by 40-50%). TNAU calculated the **net returns with SRI as $519/ha vs. $242/ha with conventional methods**. So SRI is more than doubling the profitability of rice production. This helps explain why SRI is gaining popularity in both AP and TN. These results invite scientific investigation, especially to understand what is going on in better-drained vs. more saturated soils.

4. BENEFITS FOR THE POOR: The India program of the International Water Management Institute (IWMI) has done an evaluation of SRI in Purulia, West Bengal this past season. Its data analysis has documented remarkable benefits that can accrue to a poor population with SRI even without irrigation. The current average paddy yield in the area is < 2 t/ha, as production is rainfed, with transplanting done at the onset of monsoon rains. The experience of 110 farmers who were using both SRI and conventional methods was evaluated. Even though they were not using all of the SRI practices as recommended -- less than half had planted young seedlings (<15 days) and only 12% did water management as expected – the results are as follow (pages 20-21):

- **SRI raised average yield by 32%.** One of the two communities studied had more than usual drought-stress, which lowered its SRI average yield to only a 12% increase over conventional methods; the community with more normal weather had a 50% increase in yield.
- **Straw output was increased by over 50%** in both communities. Straw is a very valuable commodity for poor households.
- **Labor productivity was increased by 43%** (kg of rice/day of labor). This is particularly beneficial for households living in poverty who depend mostly on their labor for income.
- **Labor requirements for achieving these improvements were reduced by 9%**, possibly because villagers were not using all of the methods as recommended. For them, SRI is thus *labor-saving rather than being more labor-intensive*. Over the past three seasons, the number of farmers in these villages using SRI went from 4 to 150, and it is spreading well beyond.
- **Productivity of seed was increased by more than 12 times** (kg of harvest/kg of seed). ThIS is also important for a population that lives in poverty, since it can consume the seed saved.
- Because SRI requires little seed and little time for raising seedlings, it gives poor rainfed farmers who are dependent on an uncertain monsoon unprecedented flexibility in adjusting their rice production season to climatic vagaries, 'playing the monsoon' (page 21).
- The single most important effect of SRI was to **raise net returns per acre** from Rs. 4223 with conventional methods to Rs. 7,052 with SRI. This was an **increase of 67%** -- with only partial adoption of SRI. Returns to those who got higher yields were several times greater.

So there are remakrable benefits from SRI being documented with farmers at both the high and the low ends of the economic spectrum.

5. SPREAD TO OTHER CROPS: Recently we have learned from a wheat farmer, Tadeusz Niesiobedzki in Northern Poland, that SRI concepts and adapted practices are very promising for increasing his winter wheat production (SWI). On this trip, I learned that a number of farmers have begun adapting SRI concepts and practices to, with good results, and also to ragi and bajra (finger millet and pearl millet), main staples for the poor (pages 4 and 19), also cotton.

6. INSTITUTIONAL SUPPORT IN INDIA: The **Indian Council for Agricultural Research** is now taking an active interest in SRI and is supporting demonstration trials in rice-growing

areas all across India (pages 18-19). **State governments** are also giving support, particularly in Andhra Pradesh (pages 5-6) and Tamil Nadu (page 23). We have other reports of institutional support from the Karnataka and Kerala state governments.

A wide variety of **NGOs** and farmer organizations are taking up SRI for extension. PRADAN got the work started in Purulia, West Bengal that IWMI evaluated and reported above. The Timbaktu Collective which promotes organic farming in AP and Karnataka is connected to networks of similar organizations in southern India, all of which are getting more involved with SRI (pages 9-12, 20-21, 31, 32). The **Worldwide Fund for Nature** (WWF) is supporting SRI evaluations in connection with its interest in reducing stress on aquatic ecosystems (pages 5 and 8).

Two CGIAR centers, **IWMI** and **ICRISAT**, have begun evaluating SRI and confirming much of what has been reported previously (pages 28-29). A study being done by an NGO offshoot of ICRISAT on the spread of SRI outside official institutional channels shows that this started actually in 1999. This report is documenting of the process of diffusion more thoroughly than in any other country (pages 25-26). The attention that IWMI gave to SRI at its annual IWMI-Tata meeting on water management in India was very helpful for expanding the SRI network. This includes linkages with a number of Indian agricultural universities that want to or are already doing evaluation studies on SRI and starting to look at causal explanations.

7. INSTITUTIONAL SUPPORT IN BANGLADESH: This trip included a brief visit to Dhaka for a national workshop on SRI which the Minister of Agriculture attended as Chief Guest. He and others gave very favorable comments, so it appears that 'the corner has been turned' in this country too. The Director-General of the Department of Agricultural Extension gave a very positive report on SRI based on the experience of his staff and the farmers who work with them. The evaluations done by several NGOs and Syngenta under an IRRI-funded two-year evaluation program were very convincing, with over 1,000 farmers involved in on-farm trials and comparisons. The results produced so far by the Bangladesh Rice Research Institute (BRRI) are mixed, some positive but others negative. There are still some negative attitudes toward SRI among BRRI researchers, but NGO, government (DAE), private sector (Syngenta) and, most important, farmer evaluations communicated at the workshop offset this (see pages 13-19).

8. USE OF TRADITIONAL VARIETIES. There is interest in both India and Bangladesh in evaluating the effect of SRI practices on the yields obtainable with traditional local varieties. These are widely preferred for their taste and other qualities compared to improved rice varieties. One popular variety known as Kalamdani was reported to give a yield of 12 t/ha with SRI (page 31). This is comparable to the results achieved in Sri Lanka with indigenous varieties. When grown organically with SRI methods, they should be able to command a premium price in the market. CIIFAD has started trying to promote, with partners in other countries, the SRI production of indigenous varieties for local markets and for export. We hope that this effort can attract commercial interest and support. Some exports to Europe have already been made of SRI rice from Sri Lanka and Madagascar. Possibly when proper nutritional analyses are done of SRI rice, at least some varieties will offer nutritional benefits as well as aesthetic and health ones.

These are just some highlights from the 10-day visit. More detail is provided in the report below.

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This trip was built around in invitation to participate in a national water conference organized by the India Program of the International Water Management Institute (IWMI). The theme of the conference, held in Anand, Gujarat, February 24-26, was: "India's Water Economy: Bracing Up for a Turbulent Future." SRI was chosen as one of the conference themes based on what IWMI has been learning about SRI from others' experience and its own evaluation. I was invited to chair workshop sessions on SRI the first and second days and then to make a plenary presentation on the third day. The organizers invited also Dr. Alapati Satyanarayana and Dr. T. M. Thiyagarajan, who have given research and extension leadership on SRI in Andhra Pradesh and Tamil Nadu, the two Indian states where uptake of SRI has advanced most rapidly. Six other papers on SRI were also invited from a variety of researchers. Traveling to India for the conference provided an opportunity to engage with other SRI activities in the region.

This narrative report follows the style of previous reports on visits to various countries in connection with the evaluation and spread of SRI. It will give persons who are interested in SRI a change to understand better how SRI is evolving and spreading; what are the issues being raised, the problems being encountered, and the innovations occurring; and who are the persons and what are the institutions playing different roles in this remarkable, unfolding story. While at the IWMI conference, I was surprised but pleased to learn from two NGO workers from Andhra Pradesh that they had "read all the trip reports" posted on the SRI homepage and were using them in their training programs for SRI, a use I had not previously anticipated. This is another sign of how innovative are the people contributing to the development and dissemination of SRI, and how many unexpected and unplanned things are helping SRI to succeed around the world.

The Aga Khan Rural Support Programme-India in Gujerat (February 17): I arrived in Ahmedabad at an early morning hour on a direct flight from the US and had some rest before leaving on a field trip at 9:00 with the director of AKRSP-I, Apoorva Oja, and several of his program staff. The Aga Khan Foundation some years ago sent Apoorva to Cornell for a year of graduate study on rural development, before I had gotten deeply involved with SRI, so we had not discussed it before. A member of the AKRSP-I Board of Directors, Deep Joshi, had gotten him interested in SRI as the NGO for which Deep is executive director, PRADAN, has been working with SRI in a number of states, following my visit to India in December 2002, when I spoke with a PRADAN staff member. Deep I first met in the mid-1980s when he was on the Ford Foundation staff in New Delhi. I mention this background to show how the paths by which SRI is spreading often have personal connections. SRI is, on its face, quite incredible, so it helps to have some personal association which lends credibility, to get SRI at least started. Beyond that it has to proceed on its own merits.

We had two hours in the car to discuss SRI and the rationale for agroecological development more generally before reaching a rural community where AKSRP-I has a watershed management program underway. Farmer explanations of what their village households have done to capture water in situ, reducing erosion and putting the water to good use, were impressive. We walked around part of the watershed, and it was evident that efforts to reduce rainwater runoff and to build up the water table are benefiting both the community's agriculture and water supply.

After lunch at a rural training center of AKRSP-I, Apoorva and I had several hours of discussion with his programs staff on rural development issues and strategies. There was a lot of discussion of SRI, but we also considered how its concepts and practices could be extrapolated to other crops in the semi-arid and arid environment found in most of Gujarat state, where AKRSP-I has been working for a decade. Rice is grown only in certain areas. There was particular interest in applications to wheat and millet, for which we now have some evidence that these crops too benefit from wider spacing, composting, aerated soil, etc.

The program will try out SRI next season in some coastal areas of Gujarat where irrigated rice is grown, and it will also experiment with adaptations of SRI ideas for other crops in the state. AKRSP-I has strong links to many communities in this part of India given its performance in this state over the past decade, so it should have credibility with farmers to get innovations tried out.

Acharya N. G. Ranga Agricultural University (ANGRAU), Andhra Pradesh (February 18): When arriving in Hyderabad the next morning, I was met by Dr. Satyanarayana, Director of Extension for ANGRAU, which is the agricultural university for Andhra Pradesh state. At the university, we made a courtesy call on its vice-chancellor, Dr. Raghu Vardhan Reddy, and its director of research, Dr. Padma Raju. Both had visited Cornell in 2004 with Satyanarayana, so we were already acquainted. They invited me, as a friend of ANGRAU, to attend its annual convocation (graduation ceremony) the next day.

A System of Sugar Cane Intensification? In Satyanarayana's office, while he attended to some business matters (he also serves as the university's comptroller), I met with several staff and visitors. Among them was Dr. Shashi Bhushan, senior scientist for crop protection, and coordinator of ANGRAU's District Agricultural Advisory and Transfer of Technology Centre serving Medak district. He told me about an adaptation of SRI concepts to growing sugar cane. This started with Prabhakar Reddy, one of the first and best SRI farmers in the district, who also grows sugar cane, although it also appears that a number of other versions have sprung up.

Usually, sugar cane sets, each about 8-10 inches long, are planted in rows 3 feet apart, every few inches. With this alternative system (SSCI?), they are planted in rows 5-6 feet apart, with 1-foot spacing between plants. This reduces the plant population drastically. Instead of 4 tons of sets per acre, only 600 kg/acre are planted, a reduction of 85% (similar to the seed reduction with SRI), saving farmers $80/acre ($200/ha) while also lowering costs of production. With the new system, sets are not planted directly into the soil, as usually done, with high mortality (failure to sprout and root). Instead, Reddy uses very short segments of cane as sets, each having just one bud. These sections of cane, 23 inches long, are put into plastic bags with compost and organic soil for 45 days before transplanting.

By the time the sets are transplanted, they have vigorous rooting and tillering, so there is no mortality and quick, vigorous growth. Previously just a few such sets had been raised in nurseries, to replace sets that had died. With the new system, all sets are carefully reared. Because so many fewer sets per hectare are used with SSCI – only 15% as many as usual, farmers can afford to treat each set with care and attention. This results in with much higher yield, as seen below.

With SSCI as with SRI, the soil has been enriched with compost or other organic matter. The field is mulched with 'trash' after planting to suppress weeds and conserve moisture. ANGRAU had already shown that sugar cane yield could be increased by about 10 tons/acre just by putting on mulch between rows. An added benefit of SSCI is that its wide spacing allows farmers to plant a vegetable or pulse intercrop, which adds to the net profit from the field. The 45-day delay in transplanting, rather than planting sets directly, means that Reddy is saving the cost of three irrigations and one herbicide application to control weeds.

Mulch suppresses weeds, so the use of herbicides is reduced overall, and thanks to the mulch, the number of irrigations after transplanting can be cut by half. These are major reductions in inputs. Production, on the other hand, is raised by two to three times, a huge increase. We need to get more documentation on this system so that it can be properly reported in the literature. Prabhakar Reddy, the farmer who originated many of these practices based on his SRI experience, has served as Zilla Parishad chairman for the local government and is a contact farmer for several ANGRAU faculty. His energies have gone into improving agriculture and his community rather than accumulating land. Satyanarayana told me that in the southern district of Chitoor, another farmer has developed a different version of 'SSI' using SRI principles. He has not changed the planting density as much as Prabhakar Reddy has done, but he gives more attention to the planting material, removing buds from the sets and nurturing their growth. In both adaptations, tillering is profuse.

WWF Evaluation of SRI: Shortly after noon, Satyanarayana asked me speak to participants in a training program that he is running at ANGRAU with funding from the Worldwide Fund for Nature (WWF). Its Living Waters Program is supporting an evaluation of the impact that SRI can have on irrigation water demand, recognizing that a large amount of the world's freshwater supplies is currently taken up for irrigation of rice worldwide, and this can have an adverse impact in aquatic ecosystems. This pilot study will ascertain the water-saving potential of SRI. If WWF and a panel of experts it has assembled to oversee the study are satisfied that real savings can be made, this international NGO is in a position to promote SRI in many countries for its contribution to enhanced environmental quality and biodiversity.

The training program involves field assistants (mostly experienced SRI farmers) and agricultural extension supervisors from 11 of the 22 districts in Andhra Pradesh. They will be monitoring on-farm water use with SRI methods, comparing this to use with standard methods of rice cultivation. WWF would like to know (and to have policy-makers understand) how much reduction in water use can actually be achieved with SRI. Such knowledge, if sufficiently positive, could encourage more official support for SRI dissemination. This particular study will provide a basis for predicting system-level water savings with SRI, not just at field level, and it would be followed by a more comprehensive evaluation if the first-round measurements show significant saving.

AP Department of Irrigation Support for Extending SRI: After lunch at Satyanarayana's home, we drove to the Secretariat of the Andhra Pradesh Government, being joined on the way by Dr. O. P. Rupela, a microbiologist at ICRISAT who is cooperating in the WWF study, doing soil analyses to assess the changes in soil flora and fauna associated with SRI practices. At the

Secretariat, we met for almost two hours with the Principal Secretary for Irrigation, S. P. Tucker, and ten members of his staff. They are satisfied that introducing SRI rapidly and widely within the irrigated areas of Andhra Pradesh will be beneficial for farmers and for the state, particularly by reducing irrigation water requirements.

In Andhra Pradesh like many other Indian states, water shortages have become endemic. In some areas, farmers have had to give up their rice production for lack of water (thinking incorrectly that they must keep their fields continuously flooded for best results). In many areas, shortages are causing stress, tension and even conflict. The Department of Irrigation wants to start spreading SRI to 200,000 hectares in the next kharif season. It would like to cover twice this area if irrigation control structures and operations can be improved enough to deliver small amounts of water reliably to farmers' fields so that SRI requirements can be met on that large a scale.

The Department held a first training session for 60 SRI farmers on February 7 and has scheduled more sessions. Its extension strategy will be to rely particularly on the experience, knowledge and enthusiasm of farmers who have already made SRI methods work successfully. With the support of 'master-farmers,' it is hoped to get all of the paddy fields under certain canals to be managed with SRI methods this coming season, to be able to see what system-level savings of water can be achieved. (Secretary Tucker e-mailed me a month later to say that his department had recruited 1,000 SRI farmers for training and deployment.)

Meeting with the Chief Secretary: We were given a meeting with the Chief Secretary for the Andhra Pradesh Government at 5:30. He had served previously as Secretary of Agriculture in New Delhi, so he knows agricultural subjects well. He told us that there was no need to spend any time discussing SRI practices or results because he already understands what SRI can do for the state and its farmers. He said that if SRI is endorsed both by the ANGRAU Director of Extension, Satyanarayana, who has the support of many researchers in the university, and by me from Cornell University, which is known for its agricultural expertise, that satisfies him. The Chief Secretary assured us there will be cooperation on all fronts with the Irrigation Department's efforts to bring this opportunity to farmers. This was very good to know because there has been some resistance from within the Department of Agriculture. It will be important to have such high-level support complementing the support that SRI is receiving from farmers.

ANGRAU Convocation (February 19): This was a big day for ANGRAU. Dr. Mangala Rai, Director-General of the Indian Council of Agricultural Research (ICAR) and Secretary of the Department of Agricultural Research and Education in New Delhi, had come to serve as Chief Guest for the convocation. Satyanarayana was occupied in the morning, meeting Dr. Rai at the airport. At the ANGRAU guest house where I stayed during my visit to Hyderabad, I happened to sit with Dr. Naidu, principal of ANGRAU's College of Agriculture at Naira, one of the several decentralized colleges of agriculture that the university has throughout the state.

When he asked what I was doing in Andhra Pradesh, I told him, asking in turn whether he had heard of SRI? Of course, he responded. His college had done its own SRI trials last season, and with everything carefully controlled, they had found SRI giving them a yield 2.5 times higher than their control plot. Everyone could see the difference, he said. We discussed the reasons for this difference, and he articulated very clearly the importance of and reasons for greater root

growth with SRI. He also showed a good understanding of the contribution from soil biota. An agricultural economist by training, he showed a good grasp of agricultural science. This was a gratifying way to start the day.

ICAR Interest: When Dr. Rai arrived at the guest house from the airport, I was invited to accompany him and Satyanarayana to the university. This gave me an opportunity to discuss SRI with him. Already in last kharif (summer) season ICAR supported several thousand demonstration trials throughout rice-growing areas of India. The results from this evaluation are just starting to come in. Satyanarayana had the results from 474 on-farm trials in Andhra Pradesh supervised by the Department of Extension. Average SRI yields were 7.9 t/ha, while those on control plots averaged 5.5 t/ha, a 2.4 t/ha differential with reduced inputs. In Andhra Pradesh, the average rice yield, for comparison, is 3.87 t/ha, almost 4 tons per hectare less. So the comparison was with best current practices, not with 'subsistence' methods.

There has been disagreement with some officials in the Department of Agriculture who have claimed that SRI will not be suitable for the richer rice-growing areas in the state's delta regions. (This argument is based on an article by Achim Dobermann published in *Field Crops Research*, which stated that SRI is at most 'a niche innovation,' raising yields for farmers in the poorest areas, but not appropriate for better-endowed areas.) Satyanarayana pointed out that average SRI yields in East Godavari and West Godavari districts (60 trials each), some of the prime rice-growing area in the state, were over 9 t/ha. If SRI is not suitable for delta areas, this average should have been lower rather than above the SRI average for the state. The best results were in two districts in drier areas (Medak and Adilabad). There the normal rice yield is 2.5 t/ha, and the yield on comparison plots was 6.5 t/ha. In both districts, the SRI average was over 10 t/ha. That the best SRI results came from some of the poorest districts was significant in its own way.

Ceremony and Honors: We got to the university in good time before the ceremonies started. The pomp and circumstance were a blend of Indian and British rituals, many of which are familiar in U.S. universities. A high point for me was when Dr. P. V. Satyanarayana received one of seven "Outstanding Researcher" awards given for whole ANGRAU system. P.V., a plant breeder at the Maruteru agricultural research station, was one of the first and most active proponents of SRI after seeing its results with his varieties and others at the station. We have often seen that SRI methods do not give as good results on-station as on farmers' fields. However, the soils at Maruteru may contain considerable populations of beneficial biota that respond well to SRI management practices. Another of Satyanarayana's PhD students, Dr. A. Narsi Reddy, was given one of the three highest rewards for research accomplishment.

After a splendid lunch following the ceremonies, I was pleased to meet a Cornell alumnus and former student of mine, Dr. R. K. Samanta, who has recently been promoted to become director of the National Academy of Agricultural Research Management (NAARM). He already knows Satyanarayana, having had him lecture at NAARM on research management. I encouraged Samatha to get involved with the many research issues surrounding SRI that warrant study.

A New System of Ragi Intensification? Back at Satyanarayana's office, he showed me pictures of another "SRI" – a system of ragi intensification. Ragi is the Indian name for finger millet, a crop especially important for poor households who have no access to irrigated land. Ragi is

known to produce better yields when transplanted rather than being direct-seeded. Those who want (need) the best attainable yield from ragi will manage the crop more intensively than done in the past. The standard methods of production give very low yield, only 400-800 kg/ha. Ragi's main advantage is low labor requirement and an ability to grow under harsh, rainfed conditions. But it is a risky crop, with frequent crop failure.

When ragi seedlings are transplanted at 15 or even 10 days, instead of the usual 21 days, and if given wider spacing and more organic matter in the soil, their root growth is several times greater, and their canopies much larger and greener. There were no yield figures yet to report, but judging from the pictures Satyanarayana showed me, the yield of these 'SRI' plants should be several multiples of what is obtained with conventional practice. I brought with me a poster that the Green Foundation in Bangalore has produced on its improved practices for ragi, using many SRI concepts. The Foundation's director, Dr. Vajana Ramprasad, reports that ragi yields can rise from 5-6 quintals/acre to 20-25 quintals with the new methods. Such a large increase is especially important for food-insecure households which depend on heavily on this crop. (Some weeks later, I got a message from a farmer in the Cauvery delta in Tamil Nadu State, Gopal Swaminathan, that he is getting very good growth from cotton plants raising them according to SRI ideas.)

WWF Workshop: Later that afternoon, we drove an hour to the campus of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) at Patancheru to join a WWF workshop. This had brought together WWF staff from a number of countries who are working on aquatic ecology conservation and the interface with agriculture. After an introduction by Dr. Biksham Gujja, policy advisor for global water issues and partnerships for WWF's Living Waters Program, I was asked to make some brief comments on SRI and to respond to questions. GUjja said there was no need to explain SRI. "We are quite convinced." One of Satyanarayana's colleagues Dr. K. S. Babu had spoken to the workshop about SRI that morning while we were at the Convocation. Gujja is based at ICRISAT and learned about SRI by seeing its results in a village near his family's home in rural AP.

Gujja said the most burning question (and one that we do not have a full answer for), is why SRI has not spread more rapidly in Madagascar if it has so many advantages? I said this question is often asked, as a way of dismissing SRI on logical rather than empirical grounds. Since its inception, there has been mostly indifference and even some hostility toward SRI from the technicians and government in Madagascar. This has now changed, with the Minister of Agriculture and the President now giving open support. The President has asked Association Tefy Saina, the NGO most active in promoting SRI in Madagascar, to maintain a large SRI field at his presidential residence, to show his support and to impress visitors.

I noted that rice is the most revered food in Madagascar, and traditional Malagasy culture teaches people to follow 'the ways of the ancestors.' Changing rice-growing practices is an act of disrespect for them, and this can lose their favor (and neighbors' respect and cooperation). Some independent-minded farmers have 'broken ranks' with their neighbors and relatives, but there have been cultural barriers. I suggested an analogy. It would be misleading to try to evaluate the merits and spread of Christianity by the extent to which it has been accepted in the country of its origin. Christianity is much more widely accepted and practiced outside the Holy Land than in it.

Similarly, we see much greater spread of SRI outside of Madagascar, most notably in Cambodia, Andhra Pradesh, Philippines, Bangladesh, Cuba, etc. Gujja invited us to join workshop participants for dinner at a renovated Indian monument built five centuries ago that evening. This gave us opportunity to continue the discussions on SRI.

Farmers Forum on SRI (February 20): About 9, Satyanarayana brought A. Laxmana Rao, retired chief justice of the Allahabad High Court, to the ANGRAU guesthouse. Rao is now president of an NGO called the Kisan Forum (Farmer Forum). It was made up initially of retired civil servants who wanted to see AP agriculture improve more rapidly. Membership has expanded to include private sector persons who share this goal and progressive farmers who like to interact with scientists and others about how to raise agricultural productivity. On rather short notice, the Forum had put together a Sunday morning program on SRI announcing me as the 'Chief Guest' and keynoter.

When we arrived shortly after 10 at the location where the meeting on SRI was planned, a group of about 75 persons, two-thirds of them farmers, was assembling. The Forum is just starting its third year. Mr. Laxmana Rao opened the meeting with an endorsement of 'ecoagriculture,' saying that they want to reduce and prevent the pollution of water, soil and food products. Forum members, he said, have been doing voluntary service in rural areas, spreading the message among the rural poor to use less synthetic chemicals and to use more biomass, organic inputs, manure and compost.

Justice Rao spoke about the field activity of the Centre for Sustainable Agriculture in Hyderabad, which had been working with two rural communities to introduce organic farming methods. Without any use of pesticides, the Centre and farmers had demonstrated that it is possible to get higher yields (on 600 ha in the two villages) without use of chemical inputs. When introducing Satyanarayana to the group, to say a few words about SRI in Andhra Pradesh, the chairman said "This is a person who has been a one-man army" to spread SRI throughout all the districts of the state, showing farmers how they can raise their rice yields with less seed, water and inputs.

Satyanarayana introduced a number of star farmers, including Prabharakan Reddy, one of the first SRI 'pioneers,' and Nagaratnam Naidu, who last season got 92 bags per hectare with SRI -- a yield of 16.25 t/ha. When N.V.R.K. Raju arrived a little late, he was introduced as having successfully planted SRI on 100+ acres in last rabi season, which prompted a round of applause. His harvested yield from this large area was 11.15 t/ha, a tremendous accomplishment, but Raju explained later that he was not satisfied with this performance, since some others were getting an even higher yield with SRI. Most farmers would be delighted with such a result, but he wants to excel in whatever he does. Raju has a very large poultry farming operation (800,000 birds), which is his main source of income. He has, however, become seriously involved with SRI, making and spreading improvements. Practicing SRI on a large scale requires organizational skills as much as agronomic ones, and he brings both.

When asked to give a keynote, I outlined a vision for 21st century agriculture, based on SRI experience, that would more fully utilize biological potentials and processes, emphasizing the development, health and functioning of root systems and the nurturing of abundant and diverse communities of soil organisms (from microbes to earthworms). This route would not necessarily

reject the use of agrochemicals, but it would seek to reduce dependence on external inputs, by capitalizing on the opportunities available within the genomes of plants, animals and microorganisms. This would be done for the sake of profitability and for environmental quality.

The first constraint to SRI uptake is its initial labor-intensity. However, we are finding that this can give way to labor-saving once farmers have mastered the methods through experience and as they continue to innovate and make various shortcuts. Really, the main constraint is the need for good water control to have the best results. The profitability of SRI can justify making the necessary investments in infrastructure and in organization to be able deliver irrigation water more reliably in smaller amounts.

The biggest challenge with SRI will be for the farming community to learn how to redeploy some of its land, labor, capital and water to the production of other, higher-value crops once SRI gains in factor productivity make it no longer necessary to devote so much land, labor, capital and water to the production of the staple food crop. Intensification should lead to diversification. I encouraged SRI farmers to try the new methods with some of their indigenous, local rice varieties that have been eclipsed, and maybe almost lost, by the spread of newer, 'improved' varieties. The traditional varieties have superior taste and eating qualities, and probably higher nutritional value (not yet studied). So SRI could help to conserve rice biodiversity.

Following my remarks, another speaker, a retired Chief Engineer from the Irrigation Department, Mr. Veeraiah, talked about the optimal utilization of water and how to get more yield with less water. The first question from the floor was from Balaram Reddy, a farmer who has had good results with SRI, 53 and 43 quintals per acre (13.25 and 10.75 t/ha), transplanting young seedlings at 11days. He said that he was having some difficulties with (a) the nursery phase of SRI, and (b) weeding with the rotating hoe, given his soil. Other SRI farmers were anxious to respond, so there was no need for me to speak. They did not think such difficulties are or need be serious. Sudharkar Reddy said that his own experience has showed that farmers are putting too much urea on their SRI crop. He has found that by reducing urea applications he can enhance his yield by 50%. He described his own nursery procedures and insisted that while he had had some initial difficulties, he has no problems with nursery management now. Given the black soil that he has to work with, he finds that wetting his field only once every 15 days is usually enough.

Krishna Rao from Raichur district in Karnataka state, who had come a long way for this meeting, said that with SRI he has gotten 62 bags from ¾ of an acre, which works out to be a yield of 15.4 t/ha. He has now expanded his SRI production to 15 acres, and expects to do 30 acres next time. He has developed a three-row weeder (which Satyanarayana gave me a picture of to put upon the SRI homepage) that greatly reduces his time for the weeding operation. Nagaratnam Naidu spoke up to say that he had no problem with his nursery operations (getting applauded again when he mentioned his 92 bag/acre yield). He insisted that toward the end of the season when the crop is ripening, there is no need to keep adding extra water to the field, as is commonly believed and done. He said that his field was visited by at least 2,300 farmers, who are spreading the word of his accomplishment farmer-to-farmer. Although he had already spoken fairly long, he asked for permission to read a poem about SRI that he had written in Telegu language, explaining his cultivation experience. The audience gave its full attention to the reading, though I could only admire his confidence and enthusiasm.

After N.V.R.K. Raju spoke somewhat regretfully that his SRI efforts had not attained the highest yield possible, Dr. Jagannadha Raju, head of the ANGRAU Farmers' Science Center (KVK) at Undi in West Godavari, talked about the benefits of using organic manure and its beneficial effects on soil life. Maybe N.V.R.K. Raju's yield had disappointed him because he was not able, because of the large area he was cultivating with SRI (40 ha), to apply nutrients in organic form as extensively as did the more successful farmers. Another farmer responded by affirming the value of using organic manure in the nursery. He endorses starting with very young, healthy seedlings, 8-12 days old. He said that rice plants are like human beings; the earlier they start, the more they can grow. (A nice turn of phrase, but not a very exact metaphor.) He reported that his SRI yield had been 9.7 t/ha, and he spoke about the decline in soil fertility experienced now in Punjab state after years of heavy use of mineral fertilizers there. He concluded that SRI methods can be applied to many other crops, and farmers should make their own experiments.

I was asked to respond to Raju's comment that SRI methods are not giving such good results in the low-lying delta areas, where the soil is more saturated. I said that this is not surprising since soil aeration is a key element of SRI success. However, I cited the data that Satyanarayana had from kharif season trials, showing showed 9 t/ha average yields in East and West Godavari, which is prime delta rice area. This was very good performance with SRI methods and better than the state average of 7.9 t/ha with SRI. The highest yields had come, however, from drier areas. Also, they know that their rabi (dry season) yields are higher than kharif (wet season).

I suggested further that farmers cooperate among themselves so that all will use SRI methods at the same time. That way, water issues along distributaries or minor canals can be adjusted and coordinated. It should become easier to get agreement on this as farmers come to know more about the yield and other advantages of using SRI. In the short run, farmers in such situations should experiment with raised beds, which can help keep the root zone better aerated even when the fields themselves are saturated. SRI practices should be quite compatible with raised beds and also with zero-tillage.

After the usual votes of thanks, the meeting adjourned about 1:30, well beyond the announced ending time of noon. The Forum officers had arranged a fine lunch at a restaurant across the street. I got briefed in more detail on the system of sugar cane intensification by Dr. Shashi Bhushan, and there were other interesting conversations. Only a small part of these discussions are reported here since most of the discussions over lunch were in Telegu without any translation for me.

Originally the Federation of Farmer Associations of Andhra Pradesh has proposed holding a large meeting on this Sunday. Its vice-president had emailed me at Cornell, requesting my participation as a keynoter so that the federation could further promote the spread of SRI. However, the Federation had found that because the State Assembly was still in session, it could not get any ministers to attend as it had hoped. It wanted to mobilize their support to SRI by having many farmers attest to SRI's merits in a big meeting; as a foreign guest, my presence would serve as an attraction for participation. When these plans did not materialize, this Kisan Forum meeting was a good alternative, facilitating exchange among SRI farmers and with researchers and extension leaders.

The ease of communication between farmers and scientists, which is the purpose of the Forum, was evident, even if some of the language used was more 'noblesse oblige' than fully participatory. In closing remarks, I said that Andhra Pradesh farmers appeared to be some of the most progressive anywhere in the world, willing both to accept and to make innovations. AP is moving into the vanguard for spreading SRI, and their results will have an impact on all of India. I said that I look forward to further reports on their accomplishments, problems, and modifications of SRI. (It was an indication of enthusiasm and initiative within the farming community that the state-wide organization of farmers had wanted to hold a meeting with political leaders to try to gain government support for SRI extension.)

Travel to Bangladesh (February 21): The trip to Dhaka that I made with Satyanarayana started at 4. On the way to the airport in Hyderabad, I was pleased to learn from him that one of our previous 'failures' for SRI was now corrected. For several years, agriculturalists at the Annapurna Farm in Pondicherry, part of the large ashram at Auroville which is known worldwide, had tried to make SRI work for them, but without success. When I visited Auroville in December 2002, I saw good root and tiller growth; however, eventual yields were disappointing, lower than the comparison control plots. Possibly the explanation resided in the farm's heavy clay 'cotton' soils, with pH of 8, which might not be suitable for SRI methods (perhaps less hospitable for soil microbial activity). This was disappointing, but we never expected that SRI would succeed everywhere.

A cousin of Satyanarayana, now retired from government service and an adherent to the Sri Aurobindo Ashram, who had taken an interest in SRI persuaded the board of trustees to let him conduct some SRI trials there and was able to get an SRI yield twice that with usual methods. So Auroville can be taken off off the short list of places where SRI has not worked. At the 2002 international SRI conference in China, three countries of the 15 from which we had reports reported no gains with SRI or even declines in yield: Nepal, Laos and Thailand. In all three we have since had evidence that SRI is able to increase production, even doubling it in Nepal, though the gains are not as dramatic in Laos and Thailand (yet?). We suspect there may be nematode problems in the latter two countries that are aggravated when soil is not kept saturated.

We got into Dhaka at 6:30 and were met by Dr. Muazzam Husain, coordinator of the national SRI steering committee for Bangladesh. He was formerly a professor of agricultural economics at the National Agricultural University at Mymensingh (for 30 years), and he has been working with the Bangladesh Rural Advancement Committee (BRAC) and also the Bangladesh Rice Foundation since his retirement. He has helped to set up the new BRAC University, but has poured a lot of his energy and talent into getting SRI evaluated and disseminated in Bangladesh.

The steering committee was formed in 2002 with BRAC, CARE, the Bangladesh Rice Research Institute (BRRI), the Department of Agricultural Extension, and Syngenta Bangladesh Ltd. as members. They have since been joined by a number of other NGOs and agencies. During 2002-2004, the IRRI program in Bangladesh, administering DFID funds under the PETRRA project, supported systematic evaluations of SRI by steering committee member organizations. These provided empirical confirmation of SRI's merits that led to the plans for a national seminar on SRI to which Satyanarayana and I were invited as Special Guests.

Bangladesh National Seminar on SRI (February 22): The seminar which began at 9:30 was co-sponsored by the Ministry of Agriculture's Department of Agricultural Extension (DAE) and the Bangladesh Rice Foundation (BRF), an NGO established some years before to promote the improvement and spread of rice production in the country. Muazzam was a founding member and member of its board of directors, which helps to explain why he took such an early and active interest in SRI. The chairman of the BRF, Mr. J. Syeduzzman, a former Minister of Finance, chaired the session, with Mr. M. K. Anwar, Minister of Agriculture, as the Chief Guest. The conference room of DAE was packed with about 80 participants.

The seminar was opened by the director-general of DAE, Mr. Tarique Hasan, who gave a very positive account and endorsement of SRI. Muazzam gave the keynote paper, reporting on the results of evaluations of SRI done the preceding two years by BRAC, two other NGOs (SAFE and POSD), Syngenta, and BRRI. There were six sets of farmers involved in the different evaluations, and five of the six produced very positive results, both in terms of yield and, even more, in terms of profitability. I then gave an overview presentation on Opportunities for Raising Rice Yield and Factor Productivity with SRI, having some impressive pictures from various countries to add visual elaboration to the words and numbers.

I emphasized that yield by itself is not the best objective or measure: increases in factor productivity are what make farmers and countries better off. SRI is a remarkable innovation for being able to raise the productivity of land, labor, capital and water all at the same time, something unprecedented. This is possible by changing the management of plants, soil, water and nutrients to achieve greater root system growth and functioning and to mobilize the benefits from having abundant and diverse populations of soil biota. There is no magic or mystery about SRI.

Satyanarayana reinforced these ideas in his presentation on "SRI: The need of the hour." He gave data from Andhra Pradesh, showing its spread from 300 on-farm trials in kharif 2003, to 10,000 a year later. He estimated that at least 15,000 farmers are using SRI methods this rabi season, and it is spreading fast. This is mostly because SRI is water-saving, but also because it is becoming labor-saving. He recounted the visit to Andhra Pradesh by a delegation from Bangladesh the previous April, to see SRI in practice. Most of the members of that group were present at the seminar. One of them had remarked when seeing one SRI field, with tall and vigorous plants, that this was "a rice forest." He stressed that the principles explaining such performance are known. "Nothing is new." What is new is how they are put together. He also encouraged people to think about how they can be used for other crops.

Next, the Minister of Agriculture gave a response to the three keynotes. He started by saying that Bangladesh had had good success with the Green Revolution. Rice production had been raised by 2.5 times. But with the intensive monocropping, there had been overexploitation of the soil, and the Green Revolution had run into problems. There is a continuing decrease in the area being planted to rice, about 1% per year, as land is being withdrawn from cultivation because of fertility problems or being taken over for other uses. The population is still growing by 1.5%, so there is urgent need to increase both the production of rice to feed the population and the productivity of rice cultivation to get more output from available resources.

He commented on the serious degradation of soil fertility, expressing hope that this damage can be reversible. Rice production has leveled off, and is even declining. Farmers face increasing costs of production. In Bangladesh, almost all of the inputs to rice production are more costly than in neighboring India. Because of all these 'insidious problems,' there is need to increase yield and reduce costs. The current research-extension performance is not satisfactory. Although researchers can develop varieties of rice that produce 6-7 t/ha on-station, farmers get only 3 t/ha with them. How can this gap be closed? For one thing, evaluations should be done by researchers on larger plots, not just on small pieces of land.

The stagnation in production he attributed to complacency over the Green Revolution. He noted this was not true only for Bangladesh, citing figures from China which has lost 100 million tons of production over the last five years, declining from 535 million tons to 431 million tons. The same story is seen in Indonesia and Philippines, so there need to have better linkages between scientists and farmers.

Focusing specifically on SRI, he said that if there is less need for all inputs and yet one gets more harvest, "What could be better than this?" He said that this effect "had to be established and verified," however, indicating that he is not yet fully convinced. He said this should be done under the guidance of scientists, provided that they do the evaluations on larger plots. He also expressed some doubt whether farmers would be willing to take a chance on planting just a single seedling, because this looks too risky, wanting always to put at least two in instead. But he said that what he had heard was very encouraging, and he looked forward to the recommendations that would emerge from the seminar.

The Minister stayed for the rest of the morning, which is not usual for ministers. The schedule was rearranged so that the open forum, in which the farmers present could speak about their experience, came next. One DAE staff member started the discussion off by saying that in one village in his area, 60% of farmers have already adopted SRI methods.

The first farmer to speak said that he plants his seedlings 12 inches by 12 inches (30x30 cm) and gets 25-40 tillers per plant, with a 50% increase in yield. Other farmers in his area are now going ahead with SRI too. The main problems that he has to contend with are weeds and rats. A second farmer said that it is good to use very young seedlings and to reduce the water, using a rotary weeder to control the weeds. He is getting 40-50 tillers per plant. Once the tillers are tall and the canopy closes, he has to stop the weeding, however. He complained about the high cost of electricity for pumping water (which should be an incentive to use less water with SRI).

A third farmer spoke up saying that his SRI plot is along the roadside. Farmers who see it want to know how he is cultivating when they see his standing crop. Some scientists have asked him how much it costs to establish the crop. If I heard correctly, he said only 250-300 thaka per acre. This sounds too low. However, his point in any case was that SRI offers farmers a cheaper way to produce rice.

A fourth farmer said that he was brought to BRRI and was given training and a drum seeder for doing SRI (by direct seeding rather than transplanting). His crop was initially very discouraging.

"It didn't look good. But after some days, it started looking better, and then people came to see it from distant places." (How often have I heard this from farmers in many different countries.) He said got 9 maunds of paddy rice from 8.25 decimals of land, apparently a very good yield. He said that to have good water control and be able to use a minimum of water, a farmer should have his own pump. Now there is a lot more interest in his area, he said. This farmer is trying out intercropping mustard with SRI rice, which he said looks promising. He has presently 1 of his 17 bighas of land under SRI but plans to expand this given the results he has obtained.

A fifth farmer said that when flooding damaged his SRI seedlings, a DAE advisor suggested he establish a floating seedbed, and this has worked very well -- an interesting new practice. He needs only 1.5 kg of seed, which saves him both money and labor. He reported the same experience as the previous farmer. "Initially the field looked terrible. But gradually people became convinced. At first everybody said I was a mad farmer. Now everybody wants seed from me." (They mistakenly attribute the better results to varietal differences rather than to changed management practices.) He said he has 50% of his land under SRI in this boro season.

A sixth farmer, from Comilla, said that he started SRI three years ago, on 24 decimals of land (one-quarter hectare). He uses 15-day seedlings, plants 30x30 cm, and gets 18 maunds of paddy. Because his land is low-lying, he said, it is difficult to do SRI entirely as recommended, but he is getting good results. With this feedback from farmers, the program reverted to the original schedule.

The next presentation was from the Department of Agricultural Extension on its experience with SRI. Mr. Wasiuzzaman, its director of training and the main champion of SRI within DAE, was going to make the presentation, but he had been called away from Dhaka by the Secretary, so the Director-General made the DAE presentation instead. Wasiuzzaman was the first professional agriculturalist in the country to take SRI seriously, after getting a copy of a paper on SRI that I had prepared for a Bellagio conference in 1999. After reading it carefully, he got 54 farmers in Kishoreganj district to try the new methods in 2000; they added about 2 t/ha to their yield. Since then he has been trying to get SRI extended in the country, although his promotion from district extension director to national training director has deflected him from this effort.

The DAE report documented many benefits from SRI, saying that the innovation is "moving slowly and simultaneously in various districts." The rate of acceleration, it noted, is not that high. Initial trials on farmers' fields in Kishoreganj gave yields of 5.5 to 8 t/ha in boro (winter) season, and 4.5-6.3 t/ha in T. aman (summer), with basmati yields of 1.4-2.7 t/ha. The description of what SRI entails was very concise and correct. The advantages with SRI were listed as: seed-saving, labor-saving, no additional inputs needed, irrigation water-saving, yield increase, and can be used with any variety. Limitations listed were: farmers need experience; single seedlings may become damaged; water management can be difficult; uprooting small seedlings can be difficult; keeping to the schedule can be difficult; and transport of seedlings to the field can be difficult.

The DG said after this listing: "Our farmers are so innovative that if we can get the information to them, this innovation will spread like wild-fire." He listed steps that are being taken to deal with these problems: planting seedbeds adjacent to or in the field; using bamboo or plastic trays to carry seedlings to the field; using a dry seedbed or a strip seedbed; marking out the spacing for

seedlings with a handmade rake; avoiding use of excessive water; and using the rotary weeder to control weeds. He said that more and more farmers as well as extension staff are testifying to the merits and value of the system, which is gaining momentum at the farmers' level. In 2002-03, there were 386 demonstrations under DAE supervision on 11.49 ha; in 2003-04, the number of demonstrations was 557 and the area 120.87 ha.

This positive report from the Department of Agricultural Extension was followed by a conversely negative report from the Bangladesh Rice Research Institute, replaying a divergence of opinion that had surfaced at a national SRI workshop held in December 2003. Akhter H. Khan presented the BRRI paper, which included John Duxbury and Julie Lauren from Cornell as co-authors. It started with a good and fair description of SRI, noting among other things that there was a documented reduction in water use of 28%. However, the comparison trial results reported showed usually a yield advantage for BRRI methods. In only one set of trials did SRI give higher yield: 6.03 t/ha vs. 5.79 t/ha for BRRI methods and 4.03 t/ha for farmers' practice. Other trial results showed SRI to be inferior, e.g., 7.64 t/ha with BRRI practices vs. 7.11 and 7.23 t/ha with SRI at two different spacings. And they usually showed higher costs of production for SRI methods, which is different from to experience almost everywhere else, including in other Bangladesh evaluations. The profitability calculations favored BRRI methods, contrary to the results of the other PETRRA trials financed through IRRI's Bangladesh program.

The conclusion of the report was that SRI has "no or very little adoption potential in Bangladesh" because it gives lower yields and returns and is complex to use. The constraints reported were: more labor; excessive care and management required; difficulty in water management; unsuitable spacing; high seedling mortality and production cost; complexity in transplanting; unavailability of compost material; irregular ripening; and longer field duration. The final slide reporting on SRI evaluations with farmers at Satkhu was quite at variance with the conclusion presented just a few slides before, that SRI has "no or little adoption potential." The slide said that every farmer at Satkhu was now interested in participating in SRI, and >50% expected to adopt SRI in the future. This contradiction was not addressed.

The BRRI report caused much consternation among the farmers, NGOs and extension personnel present. As it proceeded, there was more and more 'buzz' among people in the room. In fact, Muazzam's keynote paper based on two years of on-farm results with over 1500 farmers had shown an opposite picture and prospect: consistently higher yields with SRI, and greater profitability. Some of the same problems had been identified from the evaluations done with PETRRA project funding, but along the same lines as the DAE report, most of these were being dealt with by farmer adjustments and innovations.

When there was opportunity for discussion, a DAE staff member said that farmers in his area are overcoming the various limitations mentioned in the BRRI report. Last season there were 40 acres under SRI, with 7 t/ha average yield; this year there are 70 acres. A senior DAE official tried to make a reconciling suggestion. "There is still controversy in Bangladesh over SRI, with BRRI coming to different conclusions from DAE, NGOs and farmers. Why doesn't the BRF put together a team with representatives of all these groups and make some field visits, to see the results there and to talk with farmers?"

I commented that SRI is the only innovation I know where researchers have difficulty replicating farmers' results; usually it is vice versa, where farmers can't achieve yields that researchers report. In our SRI experience around the world, we frequently see researchers getting lower results with SRI in their on-station trials than farmers get with these methods on their own fields. At Los Baños in the Philippines, for example, IRRI's SRI trials have averaged only 2.1 t/ha, while Filipino farmers have gotten two and three times that much, and even more. In Southern Mindanao, the SRI trials of the Agricultural Training Institute of the Department of Agriculture in 2002 averaged 12 t/ha, and one reached 16 t/ha in 2004. Results with SRI methods depend very much on soil quality and on the life in the soil, as stated earlier.

On technical matters, I noted that in all our years of experience with SRI, we have seldom seen asynchronous (uneven) ripening, as BRRI had reported. We seldom see any more than 1-2% seedling mortality when the methods are used as recommended. And SRI crops instead of taking longer to mature, as BRRI suggested, often ripen in one to two weeks less time, even while giving higher yield. The results that BRRI reported are thus quite inconsistent with what has been obtained by researchers in China, India, Indonesia and many other countries.

Abu Bakr Sarkar, a BRRI researcher who managed one of the evaluations under the PETRRA study, spoke up. His two-season study reported very positive results with SRI in terms of yield, profitability and farmer opinions. He emphasized that SRI results depend very much on the farmer, on how motivated and how skillful he is. (He did not say, but it can be inferred, that agricultural laborers working on a research station do not apply as much care and thought to their practices as will farmers with a stake in the resulting crop.)

A BRRI researcher volunteered the thought that the problem could be one of comparison: one system being done well will be better than another system done less well, a very apt comment. There were a number of exchanges in Bangla that I could not follow without translation. The subject was obviously arousing passions on both sides. The suggestion was made again to have visits to farmers' fields, to see what is the situation in real life. Muazzam noted that water control is critical for getting good SRI results, and more effort should go into getting community cooperation on reducing and controlling water applications. There were various expressions of optimism that whatever constraints are now encountered with SRI, they can be overcome.

The chairman brought the discussion to a close and asked the Minister of Agriculture for his thoughts. He said that there are obviously various types of experience in different countries. Differences in soil biology could be important, as could the educational level of farmers. Government personnel overseeing this innovation need to be better trained to be helpful. Agriculture in Bangladesh, he reminded everyone, is practiced predominantly by small farmers, who need guidance. They cannot afford to take risks. They must be confidence in anything new before it is accepted. Even large farmers are proceeding cautiously with SRI.

The Minister said that it is important to have large-scale demonstrations, not just small plots. This is why, he suggested, farmers often cannot match researchers' results. Anyone can get a good yield on a small-enough plot with enough care, as on a research station. He understood the need for more compost and organic matter. "This is a general problem with Bangladesh soils." Some new technologies are needed to grow, handle and utilize biomass.

Before making recommendations to the government, he said there should be at least a minimum of agreement between BRRI and DAE on the efficacy of SRI. The kind of field visits recommended should be done as soon as possible, to try to resolve differences of opinion, including NGOs and farmers. There will be a need for funding of any large national effort, but once the Ministry of Agriculture is convinced, it can work through the Planning Commission to seek donor assistance. This should not be difficult to get if there is agreement on the value of this innovation. At this point, the Minister excused himself with apologies for his busy schedule, having spent the whole morning with us, listening attentively to the presentations and discussion.

Muazzam read out some points he had jotted down as possible points of agreement to be presented in a report from the seminar. He suggested that there was agreement on the potentials of SRI, and that farmers were particularly favorable, but this was modified to say that there was agreement that the potentials should be assessed more systematically with farmer participation. Other points included:

- There is need for both scientific biological and socioeconomic analysis, and on a large scale.
- A community approach to solving water management problems should be pursued.
- Spacing of plants should be 'rational,' i.e., optimal rather than maximum.
- The Steering Committee, which includes representation from the government (DAE, BRRI) and private sector (Syngenta) as well as NGOs (BRAC, SAFE, BRF and others), should formulate an action plan to be presented to the Ministry of Agriculture.
- BRF in collaboration with DAE should play a coordinating role for these efforts.
- Human resource development is very important, with training of trainers an urgent need.
- Field visits, as already discussed, should be made to both good and bad areas by April.
- Cross-visits among farmers and extension personnel are very good to get knowledge of practices and results disseminated. Possibly some visits outside the country would be helpful. The visit to Andhra Pradesh in April 2004 was a big help.
- The electronic media and mass media should be approached to get them interested in SRI.

The chairman said that the Steering Committee would take these suggestions under consideration and would formulate a more formal report, to be circulated for comments. A vote of thanks was given by Mazharul Haq, executive secretary of the Bangladesh Rice Foundation, and there was acknowledgment that this national seminar had been supported by a financial grant from BRAC.

The seminar adjourned, and box lunches were served to all. Afterwards the Steering Committee met for an hour, with representation from DAE, BRRI, Syngenta, BRAC, SAFE and BRF. The Steering Committee had been formed three years earlier after an initial national workshop held at and supported by BRAC, with Muazzam emerging as the choice for national coordinator. The group has held together, has gotten a significant grant from the IRRI program in Bangladesh to do proper evaluations of SRI in the field, and has expanded both the interest in and use of SRI from its first small beginnings in 1999-2000.

The spread of SRI in Bangladesh thus far has been undertaken, not by preference, with very modest resources and depending on a tremendous amount of volunteer effort. In Andhra Pradesh, thanks to Satyanarayana, since 2003, there has been institutional support from the agricultural university and Department of Extension, with the state and even national radio and television

involved, and a growing number of farmers and farmer organizations taking initiative to promote SRI. Hopefully with the impetus from this workshop, there can be expanded and more concerted efforts in Bangladesh.

Back to India (February 23): The next morning, Satyanarayana and I left Dhaka to travel back to the Indian state of Gujarat where IWMI was holding its 4th Annual Partners' Meet. At the airport while waiting for our flight to Calcutta, Satyanarayana told me that ICAR's Deputy Director-General for Crop Science, Dr. Kalloo, had recently visited the Andaman Islands, to inspect the post-tsunami situation there. (The Andamans are a low-lying island chain near Myanmar that is part of the vast nation of India.) Kalloo reported that the SRI trials there had done well, with a 50% increase in yield. Also, his nephew who does seed multiplication in Uttar Pradesh has started SRI there with good results. In Bihar, the Director of Rice Development has tried SRI and gotten a better yield. Satyanarayana also cited positive reports from West Bengal, Madhya Pradesh, Jharkand and Maharashtra. So SRI is getting tried and noticed now in some of the northern states of India.

That evening, as we were being driven from the airport to the conference site, facing fearsome oncoming traffic on a hazardous road, for one stretch all three others in the car -- Satyanarayana, another conference participant, and the driver -- were talking on their cell phones, making this the most apprehensive part of the hour-long trip. When Satyanarayana finished his conversation, he said that his caller was a friend who had been trying to reach him for two days, to report that ICAR DDG Kalloo, had spoken very favorably about SRI two days earlier in a keynote address before a national meeting on seed production in Coimbatore, Tamil Nadu. He commended SRI especially for its seed multiplication potential, noting also its potential benefits for farmer profitability and water saving. This was further confirmation of growing national acceptance.

IWMI Conference (February 24-26): This big affair was held at the Institute of Rural Management, Anand (IRMA), which was established by the National Dairy Development Board, a very successful operation based upon a dairy cooperative movement that began here over 50 years ago. NDDB and IRMA together have extensive training programs for farmers and managers, as well as degree programs in rural management. Their facilities are ideal for convening conferences.

At lunch after the opening plenary I got acquainted with Dinesh Kumar from the NGO known as The Timbaktu Collective, working in Anantpur district, a relatively dry and poor area in Andhra Pradesh. Kumar learned about SRI from Narayana Reddy, a leading organic farmer in Karnataka state who had read about SRI in an ILEIA newsletter in 1999. The farmers cooperating with this NGO depend entirely on groundwater for their agriculture and thus are limited by the cost of pumping and by available supply. They are more concerned with water-saving than with yield increase because if they can reduce the water that their rice crop needs, it can be used to irrigate other crops on a larger area, enhancing farm income. Thus, in this region, SRI only needs to match current yield levels while saving water to gain acceptance; any yield increase is a bonus.

When I mentioned that I had learned in Andhra Pradesh that some farmers are applying SRI ideas to sugar cane, Dinesh told me that some of the farmers with whom his NGO works are working are doing this. He said that some are using SRI concepts also with *bajra* (pearl millet),

an important staple for poor rural households. At first they thought it was a 'mistake' to put out single plants widely spaced; but after two months, the plants were 'splendid.' He could not give yield figures because not enough plants have been grown started this way. But now that farmers have seen the physiological changes induced by SRI practices, he expects them to experiment with 'SBI' in a bigger way.

Dinesh suggested at the end of our lunch discussion that we should no longer continue making the recommendation of Fr. de Laulanie – that after panicle initiation, SRI rice paddies should be kept flooded with a shallow layer of water, 1-3 cm. In his experience, soil should just kept moist during the reproductive phase, not inundated. I said that this is a conclusion toward which I have myself been moving. With his suggestion, I will raise this within our SRI network.

IWMI Report from West Bengal: The first afternoon of the conference there was a workshop on SRI that I had been asked to chair. The first paper by Shekhar Sinha and Jayesh Talati was an evaluation of the SRI experience of farmers in Purulia district of West Bengal, undertaken on behalf of the IWMI-India programme. The farmers there were working with SRI under the guidance of PRADAN, a well-respected Indian NGO promoting rural development among some of the poorest communities. SRI was introduced in rabi 2002-2003, but that first season, all rice crops were lost due to hail. However, the four farmers who tried SRI methods saw enough vigor in their plants that they were willing to try it again. Two seasons later, the number of SRI users in Purulia has risen to 150, which is why IWMI was curious to study this situation.

During lunch before the workshop, Avijit Choudhury, a PRADAN staff member working in Purulia had given me some background on the experience there. He said that the first four farmers had not been easy to convince to try SRI methods, but "now they are all proponents." They even travel to other communities, charging small fees to provide their knowledge to others.

Purulia is a rainfed area with annual total rainfall of 1400 mm, but with an irregular and unreliable monsoon. This is one of the poorer parts of India. Paddy yields average about 2 t/ha. Most households can produce only enough rice to meet their staple food needs for 3-4 months a year. The other months they must seek employment somewhere or find other means to scrape by.

With SRI, their yields can reach 5-6 t/ha, making an increasing number of households food-secure. Some farmers have gotten even higher SRI yields; and one, Lakshmi Kant, achieved a phenomenal yield of 15 t/ha on very poor soils. The next day, Sekhar Sinha, IWMI team leader, told me that he had himself measured the area of Kant's field and had himself weighed the paddy harvested from it. He confirmed that this measurement was correct, even though some scientists will consider the yield beyond belief. P. C. Mahapatra, an ICAR scientist with the Central Rice Research Institute, happened to be sitting with us at the time. He had recently completed a tour of duty in that region and volunteered that the soils in this area are indeed very poor. This sounded like a replay of our experience around Ranomafana in Madagascar ten years previously.

Such dramatic increasees in production explain the rapid uptake of SRI, from four farmers to 150. More important than yield, however, according to PRADAN, is the flexibility that SRI is giving farmers to 'play the monsoon.' SRI seed requirements are minimal, as is the area required for a nursery. Farmers can afford to start a SRI nursery for their field and then give it up, starting

over, if the monsoon is delayed. This flexibility enables them to transplant at an optimal time after the monsoon comes and get the best possible return from their limited land. It makes SRI more attractive to PRADAN, which aims to assist the poorest of the poor.

The IWMI paper presented in the workshop was done as a proper scientific evaluation. The team compiled a list of farmers who were using both SRI and conventional practices. It then studied 110 farmers in two blocks, Jhalda and Balrampur, whose rice production methods and results could be systematically compared. Forty fields were measured to have exact dimensions and avoid any exaggeration of yield from inexact estimates. The team did daily monitoring of the fields and kept records on all practices. It did in-depth interviews and conducted focus groups, and then carried out multivariate analysis of the data collected.

The use of SRI methods in Purulia was incomplete. Only 53 of the 110 did early transplanting (seedlings < 15 days) as recommended; in part because the late onset of the monsoon many used seedlings 25-30 days old. All 110 used wide spacing, and 107 used single seedlings per hill, the most basic change to be made. Only 13 of the 110 managed their water as recommended, and only 59 of the 110 did the weeding and hoeing as recommended. I wondered how they could get good results with such a truncated use of SRI. The two practices that we know from factorial trials contribute the most to yield improvement -- young seedlings, and water management—were not even 50% adopted.

The merits of the SRI 'package' were confirmed by the 9.02 t/ha yield gotten by the one farmer who did all the recommended hoeing and weeding and also water management. The average yield of paddy for all the farmers in Balrampur was 6.28 t/ha vs. 4.18 t/ha with conventional methods, a 49.8% increase; and 4.28 t/ha vs. 3.75 t/ha in Jhalda, 11.9% more. Jhalda had rather abnormal weather in summer 2004. It appears that the participating farmers were better than average in their use of standard practices.

The increase in straw yield with SRI, important for poor households, was 49 and 54% in the two areas, respectively. For very poor farmers, such increases are worth more in terms of family welfare than a 6 t/ha rice farmer moving up to 7.5-8.5 t/ha. Imagine how much better off these farmers can be if and when they use all of the SRI practices as recommended.

In the analysis of input productivity, it was found that the paddy yield per kg of seed was 845.61 kg with SRI vs. 61.35 kg with conventional methods, more than a 12-fold increase. Yield per kg of fertilizer applied was 42.4 kg vs. 36.6 kg, 16% more. Yield per man day was 46.2 kg vs. 32.3 kg, a 3% increase. For households that depend largely on their labor for their survival, this latter is the most important productivity increase.

Of interest in the debate about SRI's labor-intensity, the IWMI study found that farmers were using 369.12 hours/acre for SRI, vs. 401.75 hours/acre for conventional production. This represents a 9% reduction in labor requirements, and a saving of 184 Rs/acre (about $75/ha). Thus, while producing more rice, SRI frees up labor that can be put to other uses, including earning more income. When net return per unit of land was calculated, this showed an increase of 32%, even with incomplete use of SRI methods.

These percentage increases would be several times higher for the one farmer who used all the SRI methods as recommended and got a 9 t/ha yield, 4.5 times the average for the two blocks. They would be even higher for the farmer who got a 15 t/ha yield. This shows the potential of SRI that more if not all of the farmers in Purulia could avail themselves of. Probably more farmers will be willing to use SRI more completely once they see what their neighbors are achieving with SRI. This is an initial impact assessment of SRI. However, no first evaluation of SRI is likely to fully assess its real effects; these can only be assessed after a few years as skill and experience accumulate.

The report commented on phenotypic differences associated with SRI. Productive tillers ranged from 18-32 tillers with SRI vs. 8-14 with conventional methods; maximum tillering reached 85 tillers on a few SRI plots. When SRI roots were inspected, both their size and color were evidently quite different, with no need for measurement, the paper said.

Constraints to adoption under rainfed conditions identified were:

- Uncertainty about the timing and amount of rainfall as dry spells can cause serious losses during the grain-filling stage -- although this is not unique to SRI. With larger and deeper root systems, SRI rice plants are better able to survive the stress and produce some yield.
- Timing of planting can be affected by this variability and this can make transplanting young seedlings difficult -- unless farmers are prepared to sacrifice one seedbed and start over, as is now being done by some to get seedlings of optimum age.
- Draining fields is difficult during the rainy season -- so rabi season is more favorable for SRI than kharif.
- After rainfall, it can be difficult to achieve as much dryness in the fields as recommended for best SRI results.

The paper concluded that SRI methods, evaluated under field conditions with disadvantaged farming communities, resulted in higher yield with lower cost and thus more net income. Water management needs to be worked on by researchers and by farmers. Possibly costs can be further reduced, with yield and income enhanced, by moving toward full use of organic manures rather than continue use of chemical fertilizer. This latter was identified as an area for further study.

Mr. P. C. Mahapatra from ICAR said that many, many questions were raised in his mind by the presentation, more than could be answered in a few minutes, but he wanted to learn how to do SRI so that he could try it out himself. (It was disappointing that a member of the Central Rice Research Institute staff had not heard of SRI before.) Some of his questions were addressed, but I suggested that all the reports be presented before going deeply into any one of them because SRI is a phenomenon that can be neither proved nor disproved by any single evaluation. SRI is a biological phenomenon, so there can be great variability of results between and within countries.

SRI Report from Tamil Nadu: T. M. Thiyagarajan, dean of the Tamil Nadu Agricultural University's college of agriculture at Killikulam, next reported on research that he have been conducting on SRI with TNAU colleagues since 2000, when they first learned about SRI from colleagues at Wageningen University in Netherlands. There is much need in Tamil Nadu for an innovation such as SRI, TMT said, because water shortages are becoming more severe in the state, and agricultural production has been stagnating in recent years.

TMT's first trials on SRI methods did not show much improvement in yield with SRI methods. However, use of the rotary hoe, which aerates the soil while it eliminates weeds, showed a big effect, other things being equal, increasing yield by up to 2 t/ha. Also there was a water saving of 54% with SRI methods, greatly increasing water productivity (kg rice/m^3 water). Subsequent evaluations showed labor productivity (kg rice/day of labor) going up 41% in the wet season and 13% in the dry season. SRI plants were seen to have a higher leaf area index (LAI) during the grain-filling period, and their root volume was considerably higher at all stages, especially with rotary-hoe weeding.

TMT reported a variety of results from TNAU evaluations over the past four years, e.g., cation exchange capacity within the roots of SRI plants was higher by 33.1% compared with controls, and cytokinins, a crucial phytohormone affecting plant growth, were measured to be 28.6% greater in SRI plants. The abundance of pests associated with SRI was lower for almost all major pests: cutworms were absent in the SRI nursery whereas common in the conventional nursery (0.0 vs. 20.4); thrips were also less (0.5 vs. 6.1). In SRI fields, thrips and gall midge were significantly less; however, leaf folder and stem borer were significantly more. TMT suggested that they will do more work to control these latter pests through better nutrient management. He acknowledged that his trials are still applying large amounts of N fertilizer (as much as 150 kg/ha), which should not be necessary with SRI.

The 40-50% water-saving with SRI is attractive to the state government, and the Commissioner of Agriculture invited a proposal for extending SRI after he and other top officials visited the TNAU plots; $50,000 was allocated for trials in the Cauvery Delta and Tamiraparani river basin. TMT showed on-farm results from controlled trials for 100 farmers who used both SRI and conventional methods. Three of the 100 conventional plots exceeded 8 t/ha; 31 of the SRI plots topped this mark. Conventional yields averaged 5.7 t/ha (range 3.9-8.9); SRI yields averaged 7.2 t/ha (4.2-10.7). The 1.5 t/ha differential with a saving of water was attracting a lot of interest.

One of the benefits that farmers are commenting on is the smaller, simpler nursery requirement. One farmer made his nursery on his roof top. Seed saving is dramatic as SRI farmers use only 7.5 kg/ha (3 kg/acre) vs. 60-75 kg/ha with usual methods. The rotary weeder gives multiple advantages; less labor is required per acre, there is no need to buy and use herbicides, soil is aerated, and crop growth is promoted. TMT showed a picture of how SRI rice plants can resist lodging; an SRI plot was shown standing while rice in the neighboring conventional plot was knocked down by a storm. Another pictures showed how the SRI field remained green right up to the time of ripening.

The cost of production was calculated as 19,060 rupees/acre with SRI vs. 21,429 rupees/acre for conventional practice, an 11% reduction. While transplanting is more costly with SRI (3,200 rupees vs. 2,400), weeding costs much less (1,520 vs. 3,200) because a few persons can do it rather than have to hire a dozen laborers for hand weeding. The benefit-cost ratio was calculated as 2.25 for SRI and 1.52 for conventional methods. The net return per acre was figured to be $519 from SRI vs. $242 from conventional production.

TMT closed with a picture of a Joint Director of Agriculture who had been a strong critic of SRI in 2003. He accepted TMT's challenge: "Just you try it and then you can make your criticisms." This man is now a strong proponent of SRI, laying out over 2,000 demonstration-trials in the 2004 season. All districts are now asked to do 500 demonstration-trials, a total of 12,500 for the state, up from 6,000 last season. A World Bank project introducing water-saving technologies has accepted SRI as one of these and has already laid out 800 demonstrations. "The results have been impressive," TMT said in closing.

SRI Report from Gujarat: The next presentation was by Dr. Atul Mehta, research scientist at Anand Agricultural University in Gujarat. He and others at AAU had received a paper on SRI in 2001 and had experimented with it then, but had disappointing results and dropped the idea. Actually, they had only done wider spacing, and not the whole set of SRI practices. They got more tillers, but not more effective tillering. Then in 2003 they learned more about SRI from Dr. Satyanarayana and gave SRI another try.

The AAU researchers did replicated trials last year of 5 treatments, one of them being SRI. While there was not a significant difference in yield between the SRI trials and the conventional trials, there was a 46% reduction in water use with SRI. So water productivity was almost doubled. This will make SRI of interest to farmers and government in Gujarat. One separate trial in 2004 showed a yield advantage of 44% with SRI and a water saving of 25%; however, this was on a small plot and not enough to draw any firm conclusions.

One benefit that Dr. Mehta noted with SRI is that because SRI seedlings are transplanted after only 10-12 days, they are free of the iron chlorosis that develops in conventionally grown, older seedlings because of the poor quality of the available irrigation water, mostly brackish. The healthier SRI seedlings should grow better in the field. He described how carefully the SRI seedlings should be lifted up from the nursery, not pulled up, and how they should be carried to the field "like a baby." Although the replicated AAU trials had not shown a yield advantage for SRI, he was optimistic that its methods could make a contribution to rice production in Gujarat.

Report on Spread of SRI: The last paper for the afternoon was presented by Shambu Prasad, director of the Centre for Research on Innovation and Science Policy (CRISP). This is an NGO that has spun off from ICRISAT and is still located at its headquarters. Prasad and several colleagues have been investigating how SRI got started in India, as a case study of a process of innovation at the grassroots and an example of how scientific institutions may respond to new opportunities. He was struck that in 2004, the International Year of Rice (IYR) promoted by FAO having a number of objectives that could all be well-served by SRI, SRI was ignored or excluded from consideration. Prasad is also interested in the evolution of SRI as it is advanced by multiple sources of knowledge. This leads to addressing 'the politics of knowledge' and the way that evidence gets excluded on narrow, technical grounds, e.g., as being "anecdotal" and thus not worthy of consideration.

After a delayed start, SRI has since 2003 seen a rapid spread in India, Prasad noted. It is a difficult phenomenon to assess because it is still evolving and changing. He thought that the question, "Can SRI revolutionize the rice fields?" may not be as important as whether SRI can "revolutionize the way that scientific research is conducted." The four goals of the IYR were: to

improve nutrition and food security (implicitly emphasizing the benefits of GMO 'golden rice'), better management of water resources, environmental protection, and enhanced productivity. "All of these are possible through SRI." Yet SRI has met with vehement resistance from the scientific community, with some characterizing the controversy as 'the rice wars.' One journal article dismissed SRI reports as "UFOs," unconfirmed field observations. SRI has been tossed into the middle of the debate over genetic modification, with one article in *The Hindu* by Suman Sahai saying that SRI makes GM work unnecessary, and Kaneswara Rao contested this.

Controversies can have a useful role in science, getting attention called to new ideas, Prasad suggested. This particular controversy arises because some scientists do not accept an inversion of the usual sequence, where science leads to technology. Here, technology has been developed without science, and scientists are trying to catch up. Some are perplexed as to why if SRI works in farmers' fields, it often does not work on scientists' research stations. SRI is, however, not an something like an improved variety. It is a more complex, and a more simple innovation.

After reviewing the history of SRI, Prasad's presentation described various individuals or groups who had started trying out SRI after reading an article in the ILEIA newsletter in 1999 on SRI. He recounted how The Timbaktu Collective organized a trip for farmers living in a very dry area of Anantpur district, Andhra Pradesh to visit Narayana Reddy in neighboring Karnataka state. He was perhaps the first SRI adopter in all of India. After seeing Reddy's SRI field and learning the practices from him, these farmers came back able to adapt the ideas to their own situation.

Prasad showed a picture of a small temple at Mustikovila surrounded by brown paddy fields and another picture of the same location with lush green rice growing all around. Although this was a drought year, SRI users got 35 bags per acre (6 t/ha) using the limited rainfall and a little groundwater. Prasad noted how SRI methods had helped these farmers to convert a crisis into an opportunity. Their SRI crop on 400 plus acres was the only rice that gave a good harvest that year. Even canal-irrigated areas of the district did not have much yield. Having any crop at all in that drought-stricken season was considered a great success.

The presentation further listed a number of farmer innovations made to adapt SRI to local conditions and to reduce the labor time needed. The roller-marker which is fast replacing the 'rake' as an implement for marking square patterns on paddies to speed up transplanting was inspired by a small roller-device traditionally used to affix rice-flower decorative patterns, called *Rangoli*, on floors and walls of village houses. He cited the Kadiramangalam system of rice intensification developed by Gopal Swaminathan in Godavari delta, Tamil Nadu. This two-step transplanting strategy is able to assure high survival of young seedlings in harsh, hot climate. He described Narayana Reddy's adaptation of using pregerminated seed instead of young seedlings.

One organic farming group is growing rice seedlings in 'banana cups' and transplanting them at 7 days, Prasad reported. Various biopesticides are being made and used to protect SRI crops. He showed a picture of household-level production of the N-fixing bacteria Azospirillum for use as a biofertilizer. His conclusion was that Indian farmers are making many improvements and adaptations of SRI while spreading it among themselves, while most scientists are hanging back from the innovation or even opposing it. This raises many questions not so much about SRI as about the way that contemporary science operates. It would have been good to have several more

hours to discuss this subject in more detail, but the workshop had already run 45 minutes over time and had to adjourn because of a planned cultural event.

Another Report from Tamil Nadu: Next morning, the workshop reconvened later than scheduled because of some technical (powerpoint) delays. The session was led off by S. Jothimani from Tamil Nadu Agricultural University, who had not had time the day before to present his research on SRI and the effect of different fertilizer applications. His data showed SRI plant leaves having 25% higher total chlorophyll content. Root length and volume were greater on SRI plants, as was panicle number and length and the number of trains per panicle (148 vs. 117). Water productivity was 0.699 kg/m^3 with SRI production, and 0.253 kg/m^3 with conventional practices. Yield with SRI was 3.893 t/ha and 3.038 t/ha with conventional cultivation, a 28% difference.

Satyanarayana asked whether they had given any thought to why their on-station yields with both SRI and standard methods were lower than the state's average rice yield? Jothimani had no data with which to answer the question, but it would appear that depressed levels of biota in the soil could be an explanation, since fertilizer applications were calculated to meet plants' needs only for NPK. We are skeptical that such soil amendments are necessary with SRI practices because they could inhibit biological populations and processes in the soil.

SRI Report from Andhra Pradesh: Next, Satyanarayana made his presentation, reporting on SRI experience in AP. He started with reasons for why modern agriculture needs modification, having 'stalled' in recent years and having many undesirable side-effects. India has been producing 90 million tons of rice from its 45 million hectares of rice land, but in 2002-03, this came down to 75 million tons. A kilogram of water is required to produce half a kilogram of rice with conventional flooded production; that same water can produce 1.2 kg of rice with SRI methods, 144% more.

Seed saving is a big opportunity with SRI. If farmer save just 50 kg of rice/ha using SRI methods, this adds up to over $50 million in savings for India as a whole, which should be an incentive to adopt SRI even if there were no yield improvement. The features of SRI that Satyanarayana highlighted in his introduction were:

- No setback of transplanted seedlings, due to careful handling, good soil conditions, etc., and
- No die-back of roots during growth and reproductive phases.

These are key accomplishments of SRI practices.

Satyanarayana gave an excellent presentation on the principles underlying SRI. His summary data on yields showed the following results:

Season	No. of Farmers	SRI Yield	Control Yield	Difference
Rabi 2003-04 (ANGRAU)	94	9.67	7.13	2.54
Kharif 2004 (ANGRAU)	194	7.6	5.9	1.7
Kharif 2003 (Dept. of Agr.)	476	7.92	5.48	2.44

The farmers doing these on-farm comparison trials were evidently already better producers than the average in Andhra Pradesh, since the average state-wide kharif yield is 3.01 t/ha. This shows that high SRI yields are not an artifact of farmers starting from some low level of production, as is sometimes the case (when farmers get doubling or tripling of yield). Even state-of-the-art farmers can add several tons to their yield while reducing costs of production. Note that rabi season yields are higher, given that plants then get more sunlight and the soil is less saturated.

One farmer, Lakshmana Reddy, the inventor of the roller-marker to speed up transplanting, achieved a yield of 17.25 t/ha on his farm in the Godavari delta in rabi 2003-2004. This was an actual harvested yield from 9 acres, not a sampled yield or from a small plot. Satyanarayana told me afterwards that Reddy was disappointed that the Department of Agriculture, which supervised the measurements, would not report his harvest plot-wise, since one of his plots had a yield of 20 t/ha. He wanted to be known for having achieved by far the highest yield in India.

When Satyanarayana finished his presentation, there were too many questions to proceed to the next speaker according to schedule. Some questions suggested lingering disbelief, talking about SRI's labor-intensity as a barrier to adoption. Satyanarayana stressed that the main barrier is 'mindset.' Labor requirements with SRI will come down once the methods are learned. All new practices need some learning time. The stereotype of SRI as 'labor-intensive' is mistaken and misleading. (Satyanarayana forgot to remind workshop participants that the previous day's IWMI report on SRI in Purulia showed SRI *reducing* farmers' first-year labor requirements.)

The question with most operational implications was whether, or for how long, SRI seedlings could survive under the kind of monsoon flooding that is unavoidable on the Gangetic Plains and in many deltas in India and Bangladesh. This can be a real constraint to SRI adoption if young seedlings cannot be protected against inundation for the first several weeks. Once SRI root systems become established, however, they can resist many kinds of biotic stress including cyclone damage, Satyanarayana said.

IWMI Report on SRI in Sri Lanka: Regassa Namara from IWMI headquarters staff reported on an evaluation of SRI done in Sri Lanka in 2003 and published in 2004. He started by noting that there was no support for SRI from the national research system, so farmers are taking it up without government encouragement. Indeed, he said, his team met with "some misconceptions and discouragements" from government researchers. Because costs of rice production in Sri Lanka are above the current world market price, there is much pressure and incentive to raise productivity. SRI appears to offer this possibility, so IWMI was interested to assess its extendability within the country.

By 2002, about 3,000 farmers were using SRI in Sri Lanka, on an average of about 0.2 ha each. Namara and the IWMI study team discussed this spread with Dr. Gamini Batuwitage, who has been functioning as SRI coordinator in Sri Lanka. It then selected two districts for the study, one in the dry zone and one in the intermediate zone. They randomly selected 30 farmers in each district who were using SRI methods, and 30 who were not. Then the IWMI team did standard kinds of data gathering on SRI. Namara noted that government researchers had been negative about the new technology when approached by the IWMI team for discussions, insisting that SRI

is not founded on scientific grounds. However, what the team heard from farmers "was completely different. Farmers get very enthusiastic when they see their plants are more healthy."

When SRI farmers were interviewed, they identified many positive features (% in parentheses): seed saving (100%), more tillers (98.3%), reduced need for herbicides (91.7%), less lodging (91.4%), better seed quality (90.9%, commanding a premium price), water saving (89.7%), less pest and disease problems (88.1%), less need for chemical fertilizers (86.2%), reduced input cost (85%), more yield (83%), less labor for harvesting (79.6%, this is despite higher yield; with SRI there are fewer plants and their panicles are more uniform), less labor for transplanting (78%), and higher milling outturn (77.4%),

Disadvantages included: difficulties with water management (76.7%), need for well-drained soils (69.7%), need more work days (65%), weed control (60%), organic matter is not available (57.9%), transport of organic matter (50.9%), more labor input (50%), transplanting is difficult (36.7%), and need skilled labor (31.7%). Of the farmers not practicing SRI, 87.5% knew about it; this is remarkable since there has been no extension service support, only mass media and word of mouth. One-quarter of those who had heard about SRI but weren't using it yet said they planned to adopt it.

Namara said that Sri Lanka may present special problems for adoption of SRI because rice farmers over the last two decades have moved away from transplanting to broadcasting. SRI represents quite a departure from current trends. Also, use of herbicides instead of hand weeding has become widespread. Even so, SRI offers enough advantages that it can catch on, given what its methods of transplanting and mechanical weeding can add to yield.

Even though 'SRI farmers' in the sample were not doing all of the practices as recommended, they reported yields 44% higher than with standard practices. The IWMI team did its own sample of crop-cutting measures, which placed this differential at 33%. However, the crop-cuts also showed a somewhat higher average SRI yield than farmers reported, 6.325 t/ha. This was without full use of SRI recommendations. There was a one-third reduction in water use, and given the higher yield, it can be calculated that water productivity was raised by 90%.

The calculations of SRI users' net economic return were highly favorable, whether the cost of labor was calculated at the prevailing water for agricultural labor or at the wage for off-farm labor (an opportunity-cost calculation) or was not counted as a cost of production assuming that all labor was family labor. The latter is how most farmers look at the profitability of rice cultivation. The profitability of SRI ranged from 83 to 141% higher than with standard methods if all family labor was assumed; if labor was valued at the agricultural sector wage rate, profitability was 90 to 117% higher. If off-farm wage rages are used for the calculation, net returns from SRI methods were even higher, 143-206%. This possibility of tripling economic returns was based on economic analysis, however; it is not what farmers would actually get as income because they do not pay themselves or family members any wage.

Maybe more significant, the risk of economic loss was greatly reduced with SRI. If labor is not costed, i.e., the family labor situation, 9 (15%) of the 60 non-SRI farmers had net economic losses in the dry season while only 1 of 60 SRI farmers (1.7%) suffered a loss. In the wet season,

all had net incomes from their paddy production. If the off-farm wage rate was used to calculate profitability, on the other hand, almost half of the non-SRI farmers (29) had an imputed net economic loss in the dry season, and 22 were losing money on their rice production in the wet season. In contrast, only 6 and 2 of the SRI operations would have been unprofitable in the respective seasons. Therefore, while SRI is often characterized as 'more risky,' the IWMI evaluation showed the opposite. (A GTZ evaluation of SRI in Cambodia done in 2004 also showed adoption of SRI reducing the risks of failing to meet household income targets.)

On adoption, it was interesting that after doing a wealth analysis of the two samples, it was seen that SRI was relatively more adopted by both poorer and richer farmers compared with middle farmers, who were relatively less represented in the SRI sample. Poor farmers have more family labor to employ, and rich farmers are better able to employ agricultural laborers. When an analysis was done of disadoption, it was seen that poorer farmers were more likely to keep on with SRI than middle or rich farmers, so this was taken as an indication that SRI can contribute to more equity in the agricultural sector.

Namara concluded from the analysis that SRI has definite economic benefits and reduces farmers' risks; it raises water productivity and also has equity effects as well as advantages for the environment. The difficulties it presents include: greater labor requirements, limitations on organic material for fertilization, uncertainty about irrigation water supply, multiple and conflicting messages (from government, NGOs and others), and limited support from the national agricultural research and extension service.

Further Consideration: In the ensuing discussion, Saktivadivel from IWMI raised the problem of water control during the kharif (summer) season, when flooding for a week or 10 days may be unavoidable and harmful to small seedlings. It was agreed that this is a constraint to be reckoned with and will make SRI unviable for some or many farmers in certain areas. Satyanarayana suggested some ways in which SRI practices can be adjusted to such conditions, e.g., constructing drains or using raised beds. Under such conditions, he noted, one probably cannot get 10 t/ha. But it is still possible to get a 1-2 t/ha yield improvement with the new methods even if there is no water control.

Dr. A. R. Pathak, chief rice scientist in Gujarat, was asked for his views. He had been first author on the paper presented the previous day from Anand Agricultural University. He commented on the advantage that SRI methods can give Gujarati farmers who had only brackish irrigation water for their seedling nurseries. If plants are kept in these for 30 days, they develop iron chlorosis and other deficiencies, whereas if seedlings are removed after 10-12 days, they can be vigorous and healthy. He also commented on water-saving advantages that are very important for Gujarat.

In the Narmada command area, the government has reduced the area that can be planted to rice because of the growing water shortages within that basin. Maybe with SRI, rice production can be restored, Dr. Pathak suggested. They need to conduct more trials first, but it would be more successful to stick with a familiar crop than to try to introduce new ones to settler households.

Dinesh Kumar from Timbaktu Collective said that in Karnataka, farmers have started designing their own sprinkler systems for water-saving irrigation. One farmer is doing 10 acres with SRI this way; with KRH2 variety, he has 60-70 tillers per plant, and 260-270 grains per panicle.
The workshop was already half an hours over schedule (and participants were missing the tea break), so it adjourned to make way for the next workshop. There was no time for summarization or conclusions. The group had enough questions to have gone on another hour or two, however.

I commented in closing that it would be premature to try to make any 'bottom-line' conclusions about SRI at this point because it still evolving, still improving. There is enough evidence for an interim conclusion, however, supported by the papers presented, that Indian farmers, researchers and extensionists are well-advised to pursue SRI without pushing for any wholesale adoption. Everyone should expect SRI to be modified as they proceed. One positive outcome of the two sessions was that Madar Samad, a Sri Lankan friend from 25 years back now with IWMI and a self-appointed skeptic/critic of SRI in recent years, acknowledged that a solid scientific basis for SRI had been presented in the papers, enough to satisfy him that SRI is 'for real.'

A freelance journalist, Surelcha Sule, who writes for the Marathi language press in Maharashtra state, asked several of us to meet with her to provide background for a story she wants to write on SRI. Satyanarayana explained what has been going on within the government to support SRI. At the central level, the Ministry of Agriculture as part of its "macromission" program has provided funds for SRI demonstration trials, 800 in Andhra Pradesh in the past kharif season and several thousand in other rice-growing areas of India. The Indian Council for Agricultural Research (ICAR) through its all-India coordinated rice research program has recently put SRI into its annual technical program as one of the technologies to be investigated and promoted where appropriate. ICAR is supporting 250 'front-line' demonstrations on farmers' fields in Andhra Pradesh State, which means there must be several thousand demonstrations across India.

In addition, the state government of Andhra Pradesh has conducted and continues to conduct a large number of trials. The money that he has received from the state government for SRI work as Director of Extension he has used to provide farmers with rotary weeders and roller-markers, the only implements needed. This has been done on a community rather than an individual basis, and it seems to be a sufficient incentive. It does not take much to get farmers now to try SRI, he said. His department is developing booklets, videos, exchange visits, etc. "All farmers in Andhra Pradesh now know about SRI, whether they are practicing it or not," he asserted. He discussed a rice variety known as Masoorie which has excellent qualities and commands a good price. It had been given up by farmers because of lodging. But with SRI methods, this is not a problem, so they are being taken up widely. Someone else talked about a traditional variety Kalamdani that responds very well to SRI methods. It gives 50 tillers per plant, 80% of them effective, and a 12 t/ha yield. It too commands a very good price for farmers because it is very tasty.

After lunch, with a surfeit of notes taken from the preceding days, I skipped the afternoon sessions to work on this trip report in a lounge. While writing, I was approached by S. Kushala, a principal correspondent for The Times of India's Bangalore office, to get more information for a follow-up story on the article that it ran on SRI already in September. This article provided detailed descriptions of SRI methods and also a strong statement of support from the Karnataka state Minister of Agriculture.

A little later, R. Doraiswamy, convener of JalaSpandana, the South India Farmer's Organization for Water Management, also based in Bangalore, came over to introduce himself. JalaSpandana is now promoting SRI within its farmer networks, he said, encouraged by K. V. Rao, a very innovative Andhra Pradesh farmer whom I met on two previous visits to that state. (The farmer whose magnificent mustache I commented on in previous trip reports.) K.V. has been very dynamic in promoting SRI, and given farmers' desire to find means to save water, his message has gotten a receptive hearing. Ramasamy Selvam, an organic farmer leader in the Bhavani basin of Tamil Nadu, who was one of the earliest adopters of SRI in India, is also part of this network.

Doraiswamy told me about one woman farmer who had adopted SRI and grows traditional varieties, with high profitability. Recently, she sold 260 kg of Ponni variety rice grown organically with SRI methods for Rs. 3,450 (about $57) compared to a usual price of Rs. 1,600. As other farmers learn about this, the growing of indigenous rice varieties will surely spread. CIIFAD is working with partners in Cambodia, Madagascar and Sri Lanka to begin regularizing and promoting the production of organically-grown local rice varieties with SRI methods so that these varieties can bring a better price for farmers, in local markets and through exports. These old varieties are favored by most consumers already. If chemical-free, they will be healthier as well as tastier. We need to get nutritional analyses done of them as we are fairly sure that they can be seen to be more nutritious if analyzed biochemically.

Deep Joshi, executive director for the PRADAN, which is working on SRI at Purulia and in other parts of eastern India where there are problems of poverty and food security, also stopped by for a chat before he left to return to Delhi. He reported on very encouraging results and on local acceptance of vermicompost as an innovation in Purulia.

Plenary Discussion of SRI: The next day there were plenary presentations from the various workshops, followed by a series of three 'valedictory keynotes' in the closing session. Mine on SRI was the lead-off. Usually keynotes come at the beginning of a meeting, so this was a novel idea. My standard SRI presentation has become considerably honed down and clarified over the past year. This one was supplemented by a summary of the reports and evaluations noted above. When I finished, the first question was asked by Prof. R. P. Singh, head of the division of agricultural economics in the Indian Agricultural Research Institute, New Delhi: has SRI been introduced in the Punjab, and if not, why not? He said it sounded ideally suited to cope with the problems faced by Punjabi farmers, who are suffering from rising costs of production and also falling groundwater tables. I said that I have been trying to get SRI tried out in Punjab for several years, even writing to an old friend and prominent Punjabi ag economist S. S. Johl about this, with no apparent response. Ravi Chopra from the People's Science Institute stood up to say that he would be glad to arrange meetings for me if I could ever visit the Punjab. I said I would try.

The next question came from Hugh Turral, IWMI, who was concerned about depletion of soil nutrients, given the high yields reported, if nutrients were not returned to the soil through fertilization. I explained that our experience was that such returns were not necessary if substantial amendments of organic matter were made, enabling soil microbes to fix nitrogen or make other nutrients such as phosphorus available from the large reserves of 'unavailable' nutrients in the soil. In my presentation, I had referred to, but not explained, the contribution of

N-fixing and P-solubilizing bacteria and also of mycorrhizal fungi. He was not satisfied that this would be enough.

"The plant is like a little machine that takes up nutrients from the soil, and it needs a sufficient supply…" he began to explain. I could not restrain myself from interrupting: "I can't believe you said that. It supports exactly the point that I am trying to make. Plants are not like little machines. They are organisms, living symbiotically with millions of soil organisms, which provide nutrients and services to the plant, through its roots, and in return they receive sugars, starches, amino acids, etc. through root exudation." Plants and soil organisms have co-evolved for 400 million years, I said, ever since plants moved from a marine to a terrestrial environment, and I elaborated briefly on the 'biocentric' view of plant-soil relationships that is emerging from SRI.

(I should have recited the motto of organic farming, even though SRI is not necessarily an organic method: "Don't feed the plant; feed the soil, and the soil will feed that plant." This would have summarized the argument nicely. Afterwards during the tea break I apologized to Hugh for my rude interruption, further elaborating on how we think SRI achieves yields beyond what mainstream plant and soil science would predict.)

There was time for one more question. An IWMI staff member who is working in West Bengal but was not involved in the Purulia evaluation said that farmers in her area had observed an effect that supports our conclusions about SRI practices. As agricultural wage rates have increased, farmers have gone from paying on a daily basis to contract payment for transplanting. This has given agricultural laborers, who are paid for transplanting a certain area, incentive to plant more sparsely so as to get their job done sooner. It has been noticed that with the wider spacing, crop performance has been improving, an unintended consequence. These farmers are not practicing SRI but they might be more amenable to taking it up.

After the conference closed, a number of participants came up to ask for SRI materials to be sent to them. Among them, Prof. Dinesh Marothia, head of agricultural and natural resource economics at Indira Gandhi Agricultural University in the new state of Chhattisgarh, expressed particular interest, as his is one of the poorest states of India. K. J. Joy, secretary of SOPPECOM (the Society for Promoting Participatory Ecosystem Management), came up to say that they are starting to work with SRI in Maharashtra state. This NGO was established by two Indian colleagues with whom I worked previously when we were all involved in participatory irrigation management. At the end of the day as I was checking my email in the dormitory, an IWMI staff member working in Kashmir approached me to say that he would get more information on SRI from his colleague Sekhar Sinha, as rice is the main grain grown in Kashmir. It has relatively low yields, and there is urgent need to raise production. Kashmir agriculture has been set back by years of conflict, so this is another area where SRI benefits could be particularly valuable.

Reflections: Much more could be said about the conference interactions, and about the visit to India and Bangladesh, but this report gives anyone interested in SRI a good idea of the highlights and of the new ideas and insights coming from the ten-day trip. It was noted several times that India got a 'late start' on SRI, at least in terms of institutional involvement. Shambu Prasad's paper on the spread of SRI through NGO and organic-farming channels reported on early SRI efforts by individual farmers beginning in 1999, and he will continue to do field research on this

subject. It is now clear that SRI is getting so much attention from universities, extension systems and research institutions, as well as from government departments.

India could soon be the most dynamic country for SRI, with important innovations on things like new implements and extrapolations to other crops. The 17.25 t/ha average yield that Lakshmana Reddy got on his 9-acre farm, with one plot reaching 20 t/ha, and the 11.15 t/ha achieved by N.V.R.K. Raju using SRI methods on 100 acres, are setting the pace not just for India but for other countries. They show that the SRI yields reported from Madagascar are neither unattainable nor idiosyncratic. The empirical case for SRI is getting stronger season by season. Scientific explanations are now starting to catch up.

India has a very strong scientific establishment, so its engagement with SRI is most welcome. India also has an active and effective NGO sector that can carry SRI into difficult areas and encourage a lot of innovation. At least some government extension services are reasonably strong and effective, so they can help with large-scale dissemination. Universities can contribute both research and training, and a number of their faculty as well as PhD students are now taking an active interest in SRI's potentials. Most important, there is much evidence of farmer interest, innovation and leadership in different parts of the country. This will ultimately be the most important factor for SRI uptake and benefit.