

**REPORT ON VISIT TO PAKISTAN TO REVIEW PROGRESS WITH SRI**  
**October 17-21, 2006 – Norman Uphoff, CIIFAD**

**SUMMARY**

1. The System of Rice Intensification (SRI) is getting a later start in Pakistan than in the rest of South Asia, but it is now getting a good start with the involvement of colleagues in the **On-Farm Water Management wing** (OFWM) of the Punjab State Department of Agriculture and at the **Agricultural University** at Faisalabad (UAF).
2. The **on-farm trials** that I visited in Okara District south of Lahore were quite impressive. The increment to yield has been 30-45%, also with basmati varieties. Water use has been reduced by about one-third, and seed requirements by much more than that. Farmers expressed satisfaction with the new methods, partly because SRI rice plants have shown themselves to be much more resistant to lodging, seen after a recent severe storm at the end of the growing season.
3. Likewise, the **on-station trials** at the university are very impressive, although they are yet to be harvested. While no yield figures were available, but yield should be as good as or higher than that on the control plots with conventional practices -- achieved with 2/3 less water and 2/3 less seed. This is good and important news for Pakistani farmers. Some SRI plots that had gone without water for as much as 22 days were nevertheless growing well, attributable to their superior growth of root systems.
4. The University of Agriculture at Faisalabad is well equipped and staffed to begin doing thorough research and evaluation on the **soil microbiological aspects and effects of SRI**. This is the domain of SRI where we have least systematic scientific information. If UAF can contribute in this area, it will be a big service to the understanding and advance of SRI worldwide.
5. I was able also to give a seminar on SRI to a group of scientists at the **Rice Research Institute** at Kala Shah Kaka. The presentation was received with interest and openness, so I am hopeful that we can enlist substantial scientific expertise, across a number of disciplines, for developing better knowledge to underpin the opportunities created by SRI practice.
6. Overall, Pakistan has a **good institutional foundation for SRI work** – a government agency with experience in introducing large-scale changes (participatory irrigation management, zero-tillage, conservation agriculture); a world-class university; and an excellent research institute. Also, many Pakistani farmers, certainly most of those in the Punjab, are experienced in making technical innovations; and the need to acquire new methods for reducing water requirements is imperative. So there should be motivation as well as capacity for utilizing SRI opportunities.

## **Background**

This was my first visit to Pakistan since activity began there in 2005 on the System of Rice Intensification (SRI). Two parallel streams of SRI activity are converging. In September last year, **Dr. Mushtaq Gill**, director-general for on-farm water management in the Department of Agriculture for Punjab Province, visited Sri Lanka on government business. Gamini Batuwitage, who serves as voluntary SRI coordinator in that country, arranged some on-farm visits for Mushtaq so that he could talk with farmers using SRI methods and could learn their results first-hand. This visit satisfied Mushtaq that SRI methods could benefit the Pakistan rice sector.

Upon his return to Lahore, Mushtaq initiated a number of SRI trials and field demonstrations. Having previously given leadership for spreading and institutionalizing participatory irrigation management and conservation agriculture (zero-tillage, bed planting, laser leveling, and related practices), Mushtaq is well-positioned to get the productivity gains of SRI introduced there. Punjab Province is the country's major rice-growing region, especially for prized *basmati* rice, which is a major source of national export earnings.

During this same period, **Dr. Mohammed Arshad Mirza**, professor of soil microbiology and biochemistry in the Institute of Soil and Environmental Sciences at the University of Agriculture, Faisalabad (UAF), became interested in SRI and started some trials on the university campus. Arshad together with UAF colleagues had contributed a chapter on phytohormones to the book that I have put together on *Biological Approaches to Sustainable Soil Systems* (CRC Press, 2006). In July 2005 he visited Cornell to explore possibilities for cooperation between our two universities. After learning more about SRI, he became very interested in the soil biology and rhizosphere dynamics implied by the performance of SRI rice plants and recognized the potential benefits that SRI could have for farmers in Pakistan.

Arshad and Mushtaq got acquainted after the latter returned from Sri Lanka, at my suggestion, and they began collaborating to bring both government and academic capabilities to bear on the evaluation and promotion of SRI in Pakistan. In June 2006, Arshad submitted a proposal to the Pakistan-US Commission on Science & Technology to get funding from USAID for establishing at UAF a center for SRI evaluation and dissemination, for which I would be a co-PI (principal investigator) with other Cornell faculty also involved.

When Mushtaq learned that I would be attending the International Rice Congress in New Delhi, October 9-13, he invited me to spend a few days afterwards visiting Lahore and Faisalabad to interact with himself and others who are working now on SRI. This was a welcome opportunity to find out how SRI efforts are getting started in Pakistan. This report summarizes what I learned about the foundations being laid for SRI and about the institutions and persons getting involved. It was a very gratifying and encouraging visit.

## **A Field Visit**

After arriving in Lahore late on Wednesday, I had dinner that evening after the daily Ramadan fast with Mushtaq and **Dr. Intizar Hussain**, executive director of the International Network on Participatory Irrigation Management (INPIM). It so happened that Intizar was at the International Water Management Institute (IWMI) headquarters in Colombo when Mushtaq visited there last

September. He accompanied Mushtaq on the field visits to SRI farmers and became interested in how SRI methods, particularly their water-saving benefits, could be further assessed and spread.

The next morning, the three of us traveled together to **Okara District** where the On-Farm Water Management wing of the Department of Agriculture has a field program for making innovations in **resource-conserving technologies** (RCTs). This work is undertaken in cooperation with the **Rice-Wheat Consortium** (RWC) of CIMMYT, IRRI, IWMI and other institutions (including Cornell), and also with the Asian Development Bank, IRRI, UAF, the Pakistan Agricultural Research Council (PARC), the Okara District government, and several private companies. Soil and water testing services are being provided to participating farmers, and village seed banks have been established to assure timely availability of quality seed on a non-profit basis.

The project area is a cluster of six villages. Twenty progressive farmers in each village have been taken on as focal collaborators for testing and demonstrating innovations. These include: laser land leveling to conserve water; zero-tillage, bed planting and direct seeding to enhance soil fertility and save labor; mulching, green manuring and crop residue management through use of a turbo seeder and what is called the Happy Seeder; groundwater management and monitoring; and fertilizer management using the leaf color chart (LCC) developed by IRRI. SRI has been added as an additional innovation this past year.

Our first stop was at a petrol service station near the town of Shergarh, 120 km from Lahore, which I learned double as an **Agri-mall**. This is a new kind of rural institution -- a one-stop shopping center for farmers to get not just fuel, but also fertilizer, insecticides, technical advice, crop purchasing and storage, and custom services for direct-seeding, harvesting, etc.

Among those waiting to meet us were the district's director for agriculture, the chairman for the district government, and the district officer for OFWM. Mushtaq explained how this institution is part of a new system of government devolution currently being established in Pakistan. We were joined by **Dr. Rai Niaz**, director of the Water Management Research Center at UAF, who is involved in the project's monitoring of groundwater.

We drove to one of the villages a few kilometers away, passing many rice fields where the rice crop had become seriously lodged after a recent rainstorm toward the end of the growing season. The village looked quite typical, populated mostly by obviously resource-limited households. Niaz and I agreed that these farmers should be called neither "small" nor "poor" because it is their landholdings, not they, that are small, and they are usually actually quite good farmers.

We were met by a large welcoming committee with garlands in hand and were ushered into a large meeting with about 60 farmers as well as a dozen officials, all shaded by several huge trees. The emcee for the program was **Hafiz Mujeeb-ur-Rehman**, project manager for the IRRI-ADB project in this district. I had been in email contact with Hafiz during the summer as he became more and more pleased with the results of SRI methods in the project villages using different varieties. He had sent me pictures of their progress, so I already had some idea of what to expect. The proceedings commenced with a farmer saying/singing a prayer as is local custom.

The chairman of the local water users' association, **Argha Ali**, himself a school teacher and service provider as well as an innovative farmer, began with a description of the whole program, and then of SRI. He said: "We had the idea that such a small seedling would not work." But when he tried the methods, he found that whereas "normal" plants had 15-25 tillers, SRI plants had 55-60 tillers each. There was a 30-45% increase in yield the first season, and also a 1/3 seed saving (which suggests they are still planting too densely). Seed quality was also better, he added.

They are now combining SRI with direct-seeding and zero tillage (ZT) as well as with the use of raised beds. Saving with ZT is 2000 rupees per acre (about \$35), so even if there were no yield increase but saving of fuel and water, this is significant for farmers. Argha observed that even though with SRI they are cutting their use of urea by more than half, the SRI plants are greener. All this has led to much interest in SRI among farmers, he concluded. **Shaukat Ali**, a small farmer, next described his experience with SRI. He had started by using the methods on just 1 acre, but now had concluded that they were better than traditional methods and will expand his SRI cultivation next season.

Next to speak was **Saquib Ali**, a graduate student from UAF who is doing his thesis research in the project area under Hafiz's supervision. He is evaluating use of the leaf color chart (LCC) to reduce/optimize nitrogen applications. He said that he found it "exciting" to work with farmers in their own home area. He added that he could have done his thesis research near to the UAF campus, but he is glad to be working here, spending four days a week with farmers and passing on to them knowledge that he has gained at the university. He preferred such extension activity, he said, to "just doing pot experiments... This is a unique and new experience in my life."

When Hafiz spoke, he showed a copy of the illustrated manual on SRI that had been prepared by Dr. Bhuban Barah in the National Center for Agricultural Economics and Policy Analysis (NCAP) in New Delhi. Mushtaq had picked up a copy while at the International Rice Congress. Hafiz said they will produce something like this in Urdu, with their own pictures. "This year, the main focus of local activities will be on LCC and SRI on farmers' fields." This coming season they will proceed with SRI "in a big way" and will also get more UAF students working locally. Laser-leveling has been mostly completed in this village, with 90% of the fields now leveled, so this will make the application of small amounts of water more feasible.

Intizar and the Agri-mall manager also spoke, and then Mushtaq. He said that the purpose of all these innovations is to be able to "produce more with less," echoing the strategy of SRI. SRI use by seven farmers covered 12 acres this season, but he expected it to spread much more next year. In particular, it was impressive to see that the SRI crops had been resistant to lodging in the recent storm. Next, someone who had devised and was manufacturing laser land-leveling equipment locally spoke on his intervention. He is producing the control panel and receiver from his own design, importing only the transmitter.

Then I was invited to say a few words to conclude the meeting. I stressed the importance of managing soil, water, plants and nutrients so as to enhance the life in the soil. Under intense tropical sunshine, the top horizon of the soil gets baked and becomes mostly inert, contributing to problems of soil erosion, loss of fertility, and water runoff. Keeping the soil covered, to lower the soil temperature, is important for improving both soil fertility and crop production.

### **Farmers' Field Results**

When we went to Argha Ali's SRI field near the village, the first thing to be seen was the plants' erectness, with no lodging as in other fields. Second, the soil had good tilth and was nicely moist underfoot. Dr. Nias commented that when he had visited this same field a month earlier, it had not looked so impressive. Now, it was clearly more vigorous and productive than the other fields. Some rice plants were uprooted for comparison. A clump of three 'normal' plants had 9 tillers all together, while a single SRI plant had 45 tillers. I asked about pest and disease problems, and Argha Ali said they were less. We all stood together in the field for a picture (see end of report).

The panicles looked smaller than I am used to seeing on SRI plants, but this was because the variety growing here was basmati, normally low yielding but high value because of it is scented and has special cooking and eating qualities. The popular Super-Basmati variety is responding very well to SRI methods, Mushtaq said. We were then taken to a nearby field cultivated with a hybrid variety and normal methods. It exhibited serious lodging.

We drove to several other fields to see the use of laser leveling, zero-tillage (seeding through mulch), canal lining and other innovations. At a laser-leveled field in the project area, I experienced a momentary qualm as I thought of the billions upon billions of soil organisms that would have been killed by the soil disturbance. This gave the field to me the fleeting appearance of a cemetery. But there could be rapid recovery if conditions for microbial recuperation are favorable. Certainly a well-leveled field can increase both water control and efficiency, which is sought with SRI practices.

The field visits completed, we traveled onward to Faisalabad, reaching there about 5:30. Since we had traveled via Okara, we traversed two legs of a triangle and had had less good roads than if we had come directly. The university provided me with much-appreciated hospitality at its guesthouse. Arshad came there to greet us on arrival, and that evening after sundown, the whole group had a good dinner and conversation at a Chinese restaurant downtown.

### **On-Station Trials**

Next morning, Arshad and his PhD student **Muhammad Arif** showed us the trials that Arif has been managing as part of his thesis research. Three varieties are being evaluated: IR-6, as very short-stalked modern variety; Super-Basmati; and 99509, a hybrid. Different fertilization regimes are being evaluated with the SRI practices as the SRI evaluation was grafted onto the thesis research that Arif had already begun before his professor (Arshad) became interested in SRI.

One set of trials compares the results of applying potassium (sulphate of potash) and/or K-enriched compost, with the latter having two alternatives -- adding or not adding *L-tryptophan* @10 mg per kg to the enriched compost. L-tryptophan is a precursor of auxin, a phytohormone, to see whether stimulation of the phytohormone activity of soil microbes has a significant effect. Arif has set up 162 trial plots, testing 3 replications, randomly located, of 9 different treatments under alternative water management and fertilization conditions. Arshad and Arif plan to analyze many parameters beyond those set forth in the original research design, to look for any differences in the populations of soil organisms found in the soil around SRI vs. control plants.

When this research is completed, it will add greatly to our understanding of the soil biological dynamics of SRI. They expect to continue and expand this work, especially if USAID funding comes through for the proposed SRI evaluation and dissemination center at UAF. Similar work is now being done at ICRISAT in India by **Dr. O. P. Rupela** under a research program supported by WWF. These two initiatives are bringing world-class expertise in soil biology to bear on SRI issues. Also, **Prof. Takeshi Horie** in Japan, now retired from the University of Kyoto and serving as president of Japan's National Agriculture and Food Research Organization, has a PhD student doing his thesis research on SRI soils in Madagascar. That too should add substantially to our understanding in this area.

Mushtaq and Intizar were very pleased with what Arshad and Arif showed us. SRI plots that had received only one-third as much water and had only one-third as many plants looked likely to give yields as great as, or maybe more than, the control plots. Such increase in water productivity and seed saving will be welcome news for Pakistani rice farmers. The height and panicle size of the SRI plants was impressive, up to 80 panicles per plant, which is unusual for basmati rice. Some plots that had gone 22 days without water were growing well.

Arshad was pleased that faculty from other departments were now coming to look at these plots on the edge of the campus. Also, Arif has been bringing farmers to the plots to see SRI results. He impressed me by being more interested than most PhD students in sharing the knowledge being gained with users. Most doctoral candidates are so wrapped up in their experiments that they are not thinking beyond completion of their theses.

We discussed some research done in Madagascar on SRI by Prof. Robert Randriamiharisoa, unfortunately now deceased, with his students at the University of Antananarivo. This showed that SRI does not necessarily require large amounts of compost to be effective. Eight tons/ha did not significantly improve yield above that with two tons. The smaller amount seemed enough to 'incite' the growth of soil organisms, as Robert put it. Arif said this was his observation as well.

### **University Seminar**

We drove back to the main administration block for a meeting with the Vice Chancellor, **Prof. Dr. Bashir Ahmad**, an agricultural economist by training. When invited to preside at the seminar on SRI that I was scheduled to give at 10 o'clock, he agreed on short notice. There was a good turnout for the seminar in the university senate hall, over 100 faculty and students, all of whom stood up when the VC entered. This being a Friday and a half day for official duties, we needed to finish before noon. The presentation was oriented more than most to presenting the research foundations that have been laid for understanding SRI by researchers in Madagascar, China and India. The questions that followed were interesting:

- What is the difference between '**aerobic rice**' and SRI, and are they compatible? What is usually referred to as 'aerobic rice' are particular varieties that are found to be more suitable to limited-water conditions. There is an emphasis on genetic characteristics, whereas SRI focuses on management methods that can make rice with any genetic endowment better able to function with limited water. These are different approaches, but they can be combined since with SRI, we always want to begin with the most promising genetic potentials available.

- What are the implications of SRI for its application within the **rice-wheat farming system** which is widespread in Pakistan? Because SRI rice is grown under aerobic soil conditions, this should create or leave more favorable conditions for the subsequent wheat crop, which is disadvantaged now by having to follow a flooded crop that leaves behind anaerobic soil (and anaerobic soil organisms). We think that SRI should help to improve the wheat production as well as the production of rice within rice-wheat cropping systems.
- Can SRI be used with **direct seeding**, and if so, how is **weed control** maintained? I said that farmers in China, Cambodia, Cuba, Sri Lanka and India are experimenting with their own adaptations of SRI concepts to direct seeding. Within 10 years, I anticipate that perhaps half of SRI will be direct-seeded, because this can save labor and reduce costs of production, as well as produce more favorable soil conditions.

We are also encouraging experimentation with **raised-bed SRI** as well as zero-tillage, I added. In my presentation, I had shown a picture of no-till, raised bed rice in China, giving a yield of 13.4 ton/ha. For weed control, we favor intertillage with a **rotary hoe** or some similar implement that aerates the soil as it removes weeds. Farmers in India and Sri Lanka have already developed motorized weeders for this operation, and this seems to be feasible and likely to spread. Various labor-saving advances are being made to take advantage of the opportunities that SRI insights and concepts are creating.

Mushtaq commented on the role that universities can play in developing SRI knowledge and practice, inviting UAF faculty and students to collaborate with his OFWM program. He said that the results of the trials he had seen that morning were “really an eye opener” (although we had seen similar results in the trials that his program has sponsored on farmers’ fields in Okara). He humbly suggested that more students work with farmers “in live systems,” so that we can generate a group of researchers who could give leadership in agricultural improvement. He said that the current water productivity when growing basmati rice was “pathetic,” requiring about 4,000 liters of water to produce a single kilogram of rice. Water use in India and China is 2-3 three times more productive (although for growing coarser rice, not the fine-grained rice that is Pakistan’s pride). Mushtaq reminded everyone that “we are exporting water whenever we export rice.”

The Vice-Chancellor started his concluding remarks by suggesting that once Pakistani farmers know the results of using SRI methods, there should be no problem in getting them to adopt it. The resistance to lodging is a big plus, he noted. He liked my reference to SRI as ‘the root revolution.’ (I had cited this suggestion by an Indian farmer, who was known as “Mr. Green Revolution” for being the first farmer to use IR-8 variety, and who is now practicing SRI.) The VC said that the university can constitute an interdisciplinary team to work on SRI, recalling work that UAF faculty had done in the 1980s to analyze ‘constraints on production.’ At that time, they had identified low plant populations and low use of fertilizer as the main constraints. This is ironic, since SRI is now showing that lowering plant populations will enhance production, and use of chemical fertilizers should be replaced at least in part by the application of organic matter.

The VC also liked my suggestion that SRI concepts can probably be extrapolated to other crops. He commented that “We have been doing a lot of conventional research.... SRI is a new area for study... We have never talked much about roots.” He said that this university already has in place

a program under which it can provide a grant of 50,000 rupees, almost \$1,000, to any student who does his or her thesis research in the field with farmers. This also gets faculty to spend more time in the field. So he saw plenty of opportunity for faculty and students to tackle SRI research issues in a practical way. He closed with the welcome reminder that “We cannot impose technology on any farmer.”

Obviously, a lot of interest was sparked in SRI, not just by my presentation but by the knowledge that SRI methods are demonstrating remarkable results just a few hundred meters from the UAF assembly hall. After I had some time on the internet catching up on e-mail while my colleagues went to mid-day prayers, they took me to a very nice hotel in Faisalabad, where I had a lunch of pakoras and mulligatawny soup. We carried on further conversation while they maintained their fast. In the afternoon, Mushtaq, Intizar and I drove three hours back together to Lahore, and that evening Hafiz took me out for a late dinner, sharing a very typical and delicious local meal of mutton stew and biryani rice

### **Seminar at the Rice Research Institute**

The end of Ramadan was approaching, and Saturday was the last day before it concluded with the celebration of Eid-ul-fitr. As an indication of flexibility and collegiality among professionals in the agricultural sector in Pakistan, Mushtaq and Hafiz were able late Friday afternoon to make arrangements for me to give a seminar on SRI the next morning, Saturday, at the national rice institute at Kala Shah Kaku.

This is a 45-minute drive from Lahore, and we were there by 9:15. I spent 45 minutes talking with the institute director, **Mushtaq Ahmad**, who educated me on many of the details and intricacies of growing and exporting basmati rice, a matter of national pride but also profit. While other countries not having the same climatic and soil conditions as prevail around Lahore can raise basmati rice *plants*, he insisted that they cannot produce real basmati *rice* because others' rice production lacks the special scent and other qualities of Pakistani basmati.

The superiority of basmati rice grown in this region is validated by the higher price that it receives on the world market, although Pakistan's enviable position is being continually challenged by other countries. Ahmad was concerned to know whether SRI methods, which use less water, would produce a basmati rice of as high a quality as presently grown. One particularly desirable quality of Pakistani basmati is that its grains elongate when cooked without losing their thinness and fluffiness. This should be tested and evaluated.

The seminar began at 10, using the same powerpoint presentation made at UAF. It got a good reception from the scientists, although probably many remained skeptical because SRI results are so different from what has usually been observed. The research results that I reported from the China National Rice Research Institute in Hangzhou, this institute's counterpart in China, may have helped overcome reservations. Extensive trials have showed that when SRI practices are used, *lower* plant density produces *higher* yields per hectare than does higher density, and also that with SRI practices, *increases* in the application of N (120 vs. 210 kg N/ha) do not enhance yield if half of the N is provided in organic form. This research has not been published yet, but it will add to our understanding of how and why SRI methods achieve the kind of productivity gains that I had seen in the on-farm and on-station trials the previous two days.



### Closing Comments

Hafiz took me from the Rice Research Institute to the Lahore airport, arriving by 1 o'clock. It was amazing how in less than 72 hours, thanks to his efforts and those of Mushtaq, Arshad and others, I had been able to have such an informative visit. I had invited Mushtaq to the first SRI international conference, held in China in April 2002, and he had made arrangements to attend. However, his trip had to be cancelled at the last minute due to official duties that his superiors suddenly gave him. So he missed the opportunity to learn about SRI at that time. This delayed by more than three years the start of SRI work in Pakistan.

The International Centre for Integrated Mountain Development (ICIMOD) introduced SRI in some of the hill communities that it was working with in the Northwest Frontier Province, and it reported 50% increases in yield, with water saving, already in 2004. It had, however, no means to do any extension work on a scale like the On-Farm Water Management wing can now do, in cooperation with other government agencies and with the University of Agriculture at Faisalabad.

So there is reason to be hopeful that agencies and farmers in Pakistan can make up for lost time. The imperative of saving water, as well as cutting costs to increase farmers' income, will give impetus to the uptake of SRI probably more than will yield considerations alone. I look forward to further collaboration with Pakistani colleagues on SRI and to their benefiting from, as well as contributing to, the worldwide SRI network that has evolved over the past half dozen years.



Group standing in SRI basmati field in Okara district:

Intizar Hussain (2<sup>nd</sup> from left), Mushtaq Gill (4<sup>th</sup>), Hafiz Mujeeb-ur-Rehman (6<sup>th</sup>), Aghar Ali (8<sup>th</sup>), Norman Uphoff (9<sup>th</sup>), and Rai Niaz (on right); other names not obtained