

**REPORT ON SRI STATUS IN THE INDIAN STATES OF ANDHRA PRADESH  
AND KARNATAKA – October 5-8 and 14-17, 2006 – Norman Uphoff**

**SUMMARY AND INDEX**

1. In Andhra Pradesh, a collaborative network of organizations has emerged to work on SRI evaluation and dissemination: the state university (ANGRAU); the Directorate of Rice Research (DRR) for India; the Worldwide Fund for Nature (WWF); the state government's Department of Irrigation; NGOs such as WASSAN and CSA; and farmer organizations, with top-level support from the Chief Minister and Minister of Agriculture, so SRI efforts in that state have a well diversified support base (pp. 2-3). There is growing media interest in SRI (pp. 4-5). Government support is increasing (pp. 11-12, 18-19), and government-NGO cooperation is now gaining momentum (pp. 10-12).
2. A consortium put together and supported by WWF to evaluate and extend SRI, involving DRR, ANGRAU, ICRISAT and NGOs, is progressing very well, with soil biology work of particular interest because little such work has been done so far, and this should produce very solid and informative knowledge (pp. 7-9).
3. Farmer uptake of SRI in AP is rapid in some respects, and slow in others. An example of a small farmer who comprehended SRI with little instruction and has started making innovations with the methods is reported on pp. 5-6, with resulting spread within his surrounding area.
4. The difficulties that farmers are most frequently reporting concern water management and weed control. Some are regarding these as a deterrent, and others, as a challenge. Various methods are being devised to deal with these problems, many of them discussed at an all-day meeting of SRI stakeholders convened at ANGRAU, October 7 (pp. 12-17). A similar forum convened in Bangalore to share Karnataka experience provided confirming information (pp. 29-34). An initiative to identify and spread the best weeder designs is being planned with WASSAN (p. 18).
5. Some farmers are expanding their SRI operations dramatically, in one case to 80 acres already. Many farmers are reporting that SRI is now labor-saving for them, while also saving water and seeds, reducing costs of production and getting higher yields. This was not only reported in the Andhra Pradesh meeting but seen in visits to Karnataka villages. These visits also revealed farmer innovations in direct-seeding, transplanting seedlings raised in plastic trays (pp. 19-21). SRI is being adapted to production in dryland farming conditions (pp. 25-26). Some farmers are making a systematic connection between SRI and organic farming methods (pp. 21-24).
6. One of the most interesting visits during this trip was to a community in northern Karnataka state where farmers have by themselves developed another SRI (System of *Ragi* Intensification), called *guli ragi* in local language which applies the same kinds of management practices as used in SRI to growing finger millet, with often a tripling of yield, without dependence on chemical fertilizers (pp. 26-29). This suggests that the insights being gained from SRI experience could have broader applications to and implications for the agricultural sector as a whole.

## **Preface**

Prior to and then following the 2<sup>nd</sup> International Rice Congress held October 9-13 in New Delhi, I was able to visit SRI colleagues in these two states, spending four days in each to get updated on the progress and problems being encountered there. This report chronicles the variety of persons and institutions becoming engaged with the System of Rice Intensification (SRI) in Andhra Pradesh and Tamil Nadu. Separate trip reports have been written on the Congress [URL] itself and on a subsequent visit to Pakistan, October 18-20.

## **ANDHRA PRADESH STATE (AP)**

This is the third largest rice-producing state in India, which I have visited three times previously to learn how SRI is being introduced and utilized in AP (September 2003, May 2004, February 2005). The first SRI trials in AP were undertaken in the summer (kharif) season of 2003, after **Dr. A. Satyanarayana**, at the time Director of Extension for the state's agricultural university (ANGRAU), after he learned about the new methods from visiting Sri Lanka, where he talked directly with farmers who were using SRI successfully.

These on-farm comparison trials showed, on average, about a 2.5 t/ha yield benefit from using SRI practices, with reduction in water requirements. Given AP's increasing water shortages and frequent delays in the onset of the monsoon, with ensuing periods of drought, the possibility of reducing irrigation water requirements gave impetus to the spread of SRI in the state. At a meeting held at ANGRAU on June 29, 2006, the university registrar, **Dr. Jagannadha Reddy**, estimated that SRI use in AP had reached 40,000 hectares at that time [<http://ciifad.cornell.edu/sri/countries/india/inapfingerman06.pdf>].

Since my visit in 2005, a major change in the institutional landscape for SRI was that the Program on Land, Water and the Environment of the **Worldwide Fund for Nature (WWF)**, based at ICRISAT outside of Hyderabad, has begun to support the spread of SRI. It has funded two years of on-farm evaluations supervised by ANGRAU staff to be sure that the methods delivered the results claimed. Verification of these led WWF to get involved in supporting SRI's wider use [<http://www.iwmi.cgiar.org/dialogue/godavari/files/Jan06-Bulletin-Final.pdf> – see pp. 10-19]. It has brought together ANGRAU, several NGOs in AP, and the Indian government's **Directorate of Rice Research (DRR)** located in Hyderabad for collaborative efforts on SRI. In November 2005, WWF invited the Chief Minister for Andhra Pradesh to visit SRI farmers involved in the evaluation, and he declared that by 2006, there would be SRI demonstrations in “every village” of the state [<http://www.hindu.com/2005/11/16/stories/2005111609750400.htm>].

A number of NGOs are taking a role in SRI extension activities and networking, one of the most active being **WASSAN**, the Watershed Support and Service Network [[www.wassan.org/sri/](http://www.wassan.org/sri/)]. From the AP government side, its **Department of Irrigation and Command Area Development** has been promoting SRI use in major irrigation systems, employing WASSAN and several other NGOs in the promulgation effort. There are also farmer organizations that have been supporting the SRI promotion effort on their own.

Thus, AP has a well diversified institutional support base for working with SRI. Seen from outside, it looks well-situated to make use of the opportunities that SRI presents. However, our AP partners are very conscious of their weaknesses and limitations in bringing SRI to farmers,

and a lot of adaptations are being made or need to be made. As usual, things look different from the inside than from outside. Each perspective has its own validity and gaps. Appreciating these better was one purpose of the visit.

Upon arrival in Hyderabad from New Delhi on the morning of the 5<sup>th</sup>, Satyanarayana met me at the airport, with his colleague **Dr. Punna Rao** from ANGRAU. Satyanarayana, now retired from ANGRAU, is working as president for research and development of the Nuziveedu Seed Company. He still helps with SRI dissemination when and as he can, having played a pivotal role in the first phase of SRI evaluation and extension for the state. They drove me to the ANGRAU Guesthouse in the city, where I have stayed on previous visits. The university also provided a vehicle and driver for my entire visit.

Satyanarayana and Punna Rao commented that many farmers are now scaling up their SRI use, to holdings of 20 hectares or more, rather than using it only on small parcels as was done in the initial stages. Also, one innovation is the development of mechanized weeders so that weeding, which has demanded a considerable increase in labor with SRI, can be done more quickly and, once the capital costs have been covered, more cheaply. The greatest challenge remains how to get SRI knowledge out to small farmers, who have the most need of its productivity gains.

Another development is that a growing number of farmers are taking seriously the application of organic inputs to the soil, to enrich its biological activity. Some are using a soil supplement known as *panchakavya* handed down from Vedic times, a combination of five different materials derived from the cow: milk, yogurt, ghee, urine, and manure. These diverse substrates are said to increase the diversity of soil biota, which enhances soil fertility. Many users speak glowingly of its effects.

Satyanarayana observed that SRI proponents are dividing roughly into two groups: those who regard SRI in mechanistic terms as a set of practices that produces good effects, and those who regard it in a broader way, understanding and appreciating the mobilization of soil organisms to enhance soil fertility. This latter view, which he tries to reinforce, can benefit other agriculture as well, going beyond rice.

### **Interaction with NGO Partners and the Press**

After reaching the ANGRAU Guesthouse, we were joined by **Ravindran** and **Kishan Rao** from WASSAN and by **G. V. Ramajananyulu** (Ramoo for short), director of the **Centre for Sustainable Agriculture (CSA)**. This NGO cooperates closely with WASSAN in many activities. After reviewing the schedule that had been set up for the four days, Ravi, Kishan and Ramoo took me to the offices of WASSAN and CSA, near to each other and both near to the Center for World Solidarity, a German-based international NGO with which they are affiliated.

I was shown various brochures and posters developed in Telugu language regarding SRI and the other agroecological innovations being disseminated by WASSAN and CSA. A main focus is NPM, non-chemical pest management. This is a version of integrated pest management (IPM) that goes beyond just trying to reduce chemical use and instead to do without it. Considerable success is reported with whole villages now making their agricultural production chemical-free.

With support from the AP government's anti-poverty program, Indira Kranthi Patham (IKP), the area under NPM has expanded three years from 450 ha in a pilot phase three years ago, to 2,500 ha the next year, and to 180,000 ha this past year, according to Ravi. This was confirmed by the head of the IKP when we met him the following day.

As we walked to a meeting with WASSAN and CSA staff in one of the adjoining buildings, Ravi said that one of their biggest concerns is why the farmers with whom they are working have achieved yield increases usually in the range of 15-20% rather than getting increases of 50-100% from SRI as reported elsewhere. The WWF-funded evaluation by ANGRAU documented SRI yield increases in the 25-35% range. While farmers are pleased with this increment, especially since it is achieved with less water use and lower cost, the kind of increases reported, for example, by PRADAN in northern India are not being seen. Partly this because many AP farmers are already at a higher level of production than most Indian farmers.

This was one of the subjects to be explored in discussions with many people. For one thing, it has been difficult to get farmers to use the full set of recommended SRI practices, and to use them all of them as recommended. This could account for some of the disparity. In AP, rice is said to be a 'lazy man's crop,' i.e., a crop that is, or should be, easy to grow, not one carefully managed.

In the discussion at CSA/WASSAN, the first question raised concerned SRI use in saline soils. These are increasingly common in AP due to heavy use of chemical fertilizers over many years. So far, SRI has not been able to overcome this constraint; in saline fields, SRI methods often give lower rather than higher yields. Since SRI success depends on mobilizing the productive and protective services of soil biota, when salinization has changed or suppressed these populations, farmers need to rely on inorganic sources of plant nutrition to achieve decent yields, even though this continues to exacerbate the problem.

I commented on research by **Dr. Sudha Nair**, a soil microbiologist at the M. S. Swaminathan Research Foundation in Chennai, on saline soils in Tamil Nadu. She has shown that applying compost can alter the pH of such soils and thus restore their fertility. Her work identified the microorganism *Pseudomonas* as an active agent contributing to such remediation. This is an area where both scientific and practical research is needed because large areas of agricultural land are now badly affected, especially under tanks (local reservoirs).

I was also asked about how to deal with cold temperatures in the rabi (winter) season. In some places, this has adversely affected SRI nurseries, making the use of young seedlings impractical. Adjustments in timing and other practices need to be worked out wherever this problem arises, I said. Often, farmers should get better SRI results in rabi season because they have more water control and there is more sunlight. In the kharif (summer) season, the timing of the monsoon's onset is unpredictable, and its arrival brings serious flooding, which makes it hard for farmers to maintain soil aeration.

The meeting was interrupted for a few minutes while I took a phone call from New Delhi from a reporter for the *Financial Express* who has been following SRI and was doing a story to go along with the International Rice Congress. The article was very positive [URL]. We were joined also

by a reporter for a local Telegu-language newspaper and by **K. Venkateswarlu**, the Hyderabad deputy bureau chief for a national newspaper, *The Hindu*. He had been covering SRI for some time and had good questions. His fairly long interview concluded with the question: what are the five things you would suggest for AP government and other institutions to do to support SRI expansion? Without time to sort out priorities (there are many things to suggest), I enumerated:

(1) Evaluate, improve and make widely available **weeders** and other implements for SRI that are effective and low-cost. One of the most often reported problems that farmers are encountering with SRI is difficulty in weed control and unavailability of suitable weeders.

(2) Promote **farmer-to-farm extension** for SRI. Farmers who have learned SRI methods and used them successfully could be identified and supported as master SRI farmers, maybe given embroidered caps that make them recognized and show respect. Cross-visits among farmers are also an effective way to spread SRI.

(3) Experiment with **water management** scheduling and getting coordination among farmers and with water distribution agencies, so that the use of this scarce resource can be minimized and yield optimized. Farmers' fear of not having reliable water throughout the season is a major deterrent to SRI that must be addressed.

(4) Work on ways to increase **biomass production** on non-arable areas so that compost can be made more widely and cheaply and can more easily substitute for chemical fertilizer. Almost all soil fertility research efforts have gone into improving inorganic methods of fertilization. There is need to evaluate the potential of different plant varieties and to identify cultivation practices that entail little opportunity cost for current cropping. There is also need to have better tools and implements for cutting, shredding, processing, transporting and applying decomposed biomass on fields.

(5) Further, evaluate the responses of **indigenous rice varieties** to SRI methods. In Sri Lanka with SRI practices, these have given yields in the 6 to 12 t/ha range. While higher yields have been attained with the improved, high-yielding varieties, consumers usually prefer the cooking and eating qualities of 'unimproved' varieties. They are willing to pay a higher price for these local varieties, which may also have higher nutritional value. So systematic work with these varieties can give farmers more options and make their rice production more profitable. SRI may make the conservation of rice biodiversity a profitable proposition while contributing also to better human and environmental health.

These points were summarized very briefly in the article that appeared the next day [URL]. It was reasonably accurate, but gave exaggerated figures on some of the yield increases that I mentioned, as often happens in the press.

### **Field Visit to Nazeerabad Village**

During the lunch that followed the meeting, Kishan told me about **Ganapati**, an SRI farmer whom we were going to visit in the afternoon. Ganapati had learned about SRI just from listening to a talk that Kishan gave to a large group of farmers two years ago. He sat in the back of the audience and didn't ask any questions; he just went home and started practicing SRI, with

good results. When he started spreading SRI to other farmers on his own time, WASSAN, which was promoting watershed management in that area, recruited him to help as a local promoter.

Ganapati had the experience that farmers starting to use SRI methods often have; his neighbors mocked him for the first month that the crop was in the field, while the tiny and sparse SRI seedlings were taking root and preparing for their growth spurt after 30-35 days in the field. He said that he even went to his work on his fields in the evening so as to ‘minimize the disgrace.’ However, once the growth set in, there was no more teasing.

The drive to Ganapati’s village, in Ranga Reddy district 4 km from the town of Parigi, took most of two hours. The first hour was spent crawling through Hyderabad traffic to get out of the city. The village itself was like so many others that I have visited, with housing of very diverse quality, deeply rutted dirt roads through the village, but at least electrification. Ganapati met us and we walked through cotton and millet fields some distance to get to his rice paddies. It had rained during the past week so the paths were muddy in places. Kishan pointed out that the small creek we had to jump over was still flowing, a tribute to the watershed restoration work that villagers here had done under the WASSAN program. Before, runoff was so rapid that stream flow was torrential after a rain, but it soon subsided.

The contrast between Ganapati’s SRI plots and the neighboring ones was stark. One field was noted to be affected by salinity from past overuse of fertilizer and a lack of drainage. Its rice plants were pitiful and diseased – ‘struggling’ was the word that came to mind. Farmers pulled up plants from both plots to compare the roots. The comparison was striking in terms of different root sizes, and also root color. The bunch of six plants pulled up from one ‘normal’ hill could not compare with any single SRI plant.

Several of the SRI plots did not look as vigorous as the first one we visited. Ganapati explained that these had been ‘dibbled’ (direct-seeded), and he was still hopeful that their yields would turn out to be profitable because of the saving of time and cost for labor. He is experimenting with several spacings and methods. We walked around 7 or 8 SRI plots with different combinations of management practices. From our conversation, it was clear that Ganapati understands the principles of SRI very well and is working on the pragmatics of their application. He said that other farmers were now taking an interest. In a neighboring village, one large farmer now has a 10-hectare field of SRI, showing that the methods are not limited to smaller farmers like himself.

The bunds were still muddy and slippery from the rain, so I was not the only person to slip off at least once. We spoke with a small group of women who were weeding. They were family members rather than hired laborers, and they spoke very positively about SRI. When asked to name any problems that they had encountered, they said that now there are none, although they did acknowledge that some learning was required of them at first.

I have no way of knowing the extent of spread from this ‘oasis’ of SRI, but it was an impressive demonstration, in particular because of Ganapati’s imagination and willingness to work hard – and to share his knowledge. He rode back with our group to Hyderabad to attend an international workshop being held at ICRISAT the next day, where he would communicate his SRI experience to others. En route back we stopped at the communication center in Parigi that WASSAN set up

to consolidate the work done in the area on watershed management. It now includes promotion of SRI as one of its functions.

### **Field Trials at ICRISAT and Meeting of WWF-Supported Team**

The next morning, Punna Rao picked me up at 7:45 to drive to ICRISAT, the International Crop Research Institute for the Semi-Arid Tropics at Patancheru, outside Hyderabad. When I first visited this international agricultural research center about 25 years ago, it seemed a long way from Hyderabad. Now the city stretches out right to ICRISAT's doorstep. I was coming to meet with the joint WWF-ICRISAT program on land, water and environment, headed by Dr. Bikram Gujja, currently back at WWF headquarters in Switzerland. The program manager, **Dr. Vinod Goud**, was there to meet us and introduce me to others who are collaborating in a multi-disciplinary, multi-institutional evaluation of SRI.

**M.V.R. Murthy**, a rice scientist who previously worked at IRRI in the Philippines and who is now a consultant for WWF working on, among other things, SRI evaluation, introduced himself, and we had a good conversation. He provided some helpful insights into the resistance that SRI has encountered from the scientific community. Soon a team from **Directorate of Rice Research (DRR)** arrived. This is the main rice research arm of the Indian Council for Agricultural Research (ICAR). WWF through its collaborative program with ICRISAT has been supporting DRR involvement with SRI trials and also wider cooperation engaging ANGRAU and WASSAN, CSA and other NGOs in joint evaluation efforts. This is an ambitious undertaking to advance both the understanding and acceptance of SRI. Ravi, Kishan and Ramoo joined the group discussion as partners in this evaluation exercise.

The DRR team included: **Dr. L. V. Subba Rao**, senior plant breeder in the Crop Improvement Section; **Dr. R. Mahender Kumar**, senior agronomist; **Dr. C.M. Padmavathi**, senior entomologist; **Dr. K. Surekha**, senior soil scientist; and **Dr. P. Muthuraman**, senior agricultural extensionist. The latter, known as Raman, had been previously in e-mail communication with me, so it was good to meet him finally.

Also joining us was **Dr. C. Shambu Prasad** from the Xavier Institute of Management and Business in Orissa. He was previously on the staff of ICRISAT so he was well-acquainted with everyone here. He was in a unit at ICRISAT studying processes of utilizing scientific innovation. He began studying several years ago the introduction of SRI into India as a case study and has been documenting the process as it unfolds, rather than having to reconstruct it retrospectively as historians of science and technology usually do.

We went to observe two sets of SRI trials some distance from ICRISAT headquarters. The plants were in the middle of their growth cycle so we could only assess vigor of growth, not ultimate agronomic performance. Mahender explained that the trials are evaluating 'full SRI' compared with standard rice-growing practice (older seedlings, denser planting and flooding), and also with what they are calling 'Eco-SRI,' which is without any use of agrochemicals. These management systems are being evaluated with replicated trials using three different improved varieties. Mahender accepted the suggestion that next year they incorporate some indigenous varieties into their comparison trials.

In the set of plots on lower, heavier soil with poorer drainage, it was not so clear whether the SRI treatments are doing better; any assessment will have to await the harvest results. However, in the plots on lighter, better-drained soils, the better growth of the SRI plants was visible from afar. One could pick out the SRI plots by their color -- darker green vs. lighter green.

DRR scientists were quite pleased with the effect of SRI practices, and Padmavathi, who is doing entomological evaluations, said that there are marked differences in pest numbers and in the populations of beneficial insects. Her final report on this will be very interesting. DRR scientists also commented on the satisfaction they are getting from this team effort which brings them together across disciplines, not the normal mode of operation in contemporary science. They thanked WWF for making this possible, and there was evident excitement about what they are seeing and learning from this project.

When we returned to the ICRISAT complex for a group discussion, we were joined by **Dr. O. P. Rupela**, a soil microbiologist on the ICRISAT staff who is providing his expertise to evaluation of SRI impacts. Rupela contributed a chapter to the book that I edited on biological approaches to sustainable soil systems (CRC Press, 2006), so we were already acquainted.

Rupela reported on his findings so far. He started by working with a number of the farmers in the WWF study, taking soil samples at various times from the fields of 21 farmers during the first two seasons, and then from 27 farmers in the third season, about 10% of those in the whole study. He complemented the farmers for their active involvement with SRI and with the evaluation of it, saying "hats off" to them. He is evaluating microbiological, soil biological, and soil chemical differences between SRI and non-SRI fields.

Microbiological comparisons include: total bacteria, total fungi, total actinomycetes, siderophore producers, nitrogen fixers, phosphorus solubilizers, and *Pseudomonas fluorescens*, an organism known to have beneficial effects on soil fertility. For overall soil biology comparisons, he has measured microbial biomass carbon, microbial biomass nitrogen, and dehydrogenase, an enzyme reflecting microbial activity. Then he also has done standard chemical comparisons: pH, electrical conductivity, total and available nitrogen and phosphorus, and percent of organic carbon. This is an ambitious battery of tests.

So far, he had not found significant differences in the total numbers of microorganisms between SRI and non-SRI fields, but there were differences with regard to certain beneficial bacteria, particularly those identifiable as plant-growth promoters, which are generally 14-19% higher in SRI than control soils. Also, differences are more pronounced in the post-rainy (rabi) season than in the rainy (kharif) season, which could be expected since soil conditions are more aerobic in rabi season. SRI plots had 7-25% higher microbial biomass C and N in rabi season, but there was no significant difference seen in the kharif soil comparisons.

These differences were correlated with yield differences, though not consistently. SRI plots had generally higher yields (23-29%) in both seasons, although the means were not statistically significant because of large variations, which is understandable since biological populations and effects can fluctuate widely compared to chemical and physical parameters. In the rabi season, all but one farmer had a higher SRI yield than on the control plots; in kharif, 24 out of 27 farmers

harvested higher yields in SRI than control plots. Rupela showed pictures of root differences between the two cultivation methods, but said this work is still in process.

Because of the difficulties in controlling the treatments -- farmers did not practice SRI uniformly, and their control practices also varied -- Rupela is now shifting the focus of his research to analyzing effects on ICRISAT plots where treatments can be more standardized, after gaining a better understanding of biological dynamics from studying differences under field conditions. Everyone found his work fascinating, since there is so little prior knowledge of these parameters, which are so critical to understanding and practicing SRI.

In the ensuing discussion, there was an interesting report on the digestibility of SRI straw vs. 'regular' straw. A staff member of the International Livestock Research Institute (ILRI) who is stationed at ICRISAT undertook this analysis as a matter of his own curiosity. He found that the Eco-SRI was the best, but that SRI straw was better than 'regular' straw. I had expected that SRI straw might rank lower than 'regular' rice straw because when plants are grown under aerobic soil conditions, their uptake of silicon should be greater. We find that the tillers and the leaves of SRI plants are tougher and harder, which is consistent with higher silicon content. However, this report indicates that overall, digestibility of SRI straw is not reduced, an important consideration especially for small farmers.

We were told about plans to do some systematic evaluations of the nutritional value of SRI rice vs. 'regular' rice grains, through the National Institute of Nutrition, conveniently also in Hyderabad. This will be important to know since if SRI rice is demonstrably more nutritious, it should be possible to get for SRI farmers a higher price for their rice, which will give them more incentive to use these eco-friendly practices.

We discussed how the on-station trials we had just seen were confirming the broader observation, but one not calibrated yet, that SRI rice can perform better in well-drained soils than on heavier, low-lying clay soils which have been traditionally regarded as better soils for rice. This view has not been borne out in inter-district comparisons in Andhra Pradesh. This probably means that rice-growing can be considerably extended in area. The results from well-controlled, on-station comparisons between performance on different types of soils will be useful information to have.

Ramoo raised the issue that in many places, there has been disadoption of SRI after farmers tried it for one or two seasons. None were dissatisfied with SRI, he said. They acknowledged its advantages. But various constraints have been encountered, such as the difficulty of reducing in-field water applications within larger irrigations systems that are not being managed for SRI requirements, which makes it hard to maintain soil aeration. Also, often the weeders that have been made available are not well-suited to the particular soils, or are not well-made and suffer breakdowns. This is also a deterrent to SRI practice. He observed sagaciously that the extension system has been designed to deliver things (seeds, sprays, etc.) rather than to change people's attitudes and thinking. So this adds to the challenge of getting SRI extended.

After being hosted by WWF for lunch, Ravi, Kishan, Ramoo and I went back into Hyderabad to meet with administrators with whom they are working on SRI dissemination. This would give me a better idea of how the NGO interface with government agencies is progressing.

## Department of Irrigation and Command Area Development

At this department's headquarters in the city, we were met by **Srinivasan** from the Water and Land Management Training and Research Institute. This agency, known as WALAMTARI, has coordinated the Department of Irrigation's SRI extension efforts. During my previous visit in February 2005, I met with both Srinivasan and the Department's Secretary, Mr. S. P. Tucker, who had expected to be able to meet me again this time but was detained on other business. We were joined by **Sanjay Gupta**, Special Commissioner for Irrigation and CAD.

To promote the adoption of SRI in large-scale irrigation systems, Srinivasan explained that the WALAMTARI had 'jumped in' in the 2005 kharif season, contracting with four NGOs -- WASSAN, APARN, MARI, and Jalaspandana -- to get each working in some selected irrigation systems. The NGOs respectively undertook a variety of activities, including awareness meetings, demonstrations, exposure visits, farmer field schools, SRI call centers, electronic media communication, print media, mass communications, and input support for implements.

The call centers were a particularly interesting idea, being established in the respective irrigation schemes. Their telephone numbers were communicated to farmers through the district editions of major newspapers. Each center had a technical person continuously available for consultation. CDs and brochures on SRI were also available there, and the center could provide resource persons to farmers and to communities upon request. Information was provided also on SRI demonstrations and implements.

To build awareness, there were wall writings posted in public places, and an SRI film was produced and shown on cable network TV. Orientation meetings were convened at different levels, and exposure visits were organized for farmers to see other farmers' SRI fields. The farmer field school numbers showed large inter-system differences in the breakdown that I was given. These are summarized in the table below, grouping the more responsive and less responsive systems: SRSP and PJP vs. KC Canal and RDS. No explanation was offered for why the two pairs, starting out similarly in kharif 2005, diverged so dramatically in rabi 2006, but then made up much of the difference by the third season. In terms of area, the expansion in three seasons was nine times; in terms of number of farmers, it was 18 times.

Irrigation Systems	Kharif 2005		Rabi 2006		Kharif 2006	
	Farmers	Acres	Farmers	Acres	Farmers	Acres
SRSP and PJP	54	120	307	664	1,357	1,625
KC Canal and RDS	53	171	40	72	517	1,113

The overall field experience was summarized in the report Srinivisan gave me as follows:

- Low seed rate, with a saving of 22-27 kg of paddy in seed cost.
- Short nursery period – 7-8 days compared with 25-30 days – was considered good.
- Weeding is less costly if rotary weeders can be used.
- Incorporation of weeds in the soil as organic matter is also good.
- Less water requirements are important, estimated to be about half the normal use.
- More number of productive tillers – 30-50 vs. 15-20 – contributes to higher yields.
- SRI requires good drainage facilities.
- The highest yield per acre so far is 44.3 quintals in rabi 2006 (10.75 tons/ha).

Srinivasan and Gupta assured us of that the Department is satisfied with the start made, although they like others had hoped for even more rapid scaling up. The joining of government and NGO efforts is a positive development. I would have liked to see more explicit involvement of farmer organizations, e.g., irrigation water user groups, but that apparently is coming.

### Meeting with Poverty Program Administrator

Later in the afternoon, Kishan, Ravi, Ramoo and I paid a call on **Vijay Kumar**, chief executive officer of the Society for tElimination of Rural Poverty, in his office. This is a state government program for poverty eradication through social mobilization and empowerment of the poor. Kumar was still working at 5 o'clock and in no apparent hurry to leave.

We talked for an hour and a half about many things, first about SRI and the opportunities which WASSAN and CSA (and CIIFAD) think it can provide for increasing food security and incomes of poor households, but then about community organization and strategies for local mobilization and empowerment. Our CIIFAD experience in Madagascar with establishing community granaries, to give rural producers a better and fairer price for their grain as well as a stock of grain on hand for local food security and seed needs, could be relevant for Indian programs.

The AP poverty program has been supporting CSA and WASSAN efforts to spread what is being called *non-chemical pest management* (NCM), commented on above. NCM is very compatible with SRI practices, so it seems that the AP poverty program working together with NGOs can be a good vehicle for extending SRI to poor rural households. SRI would be particularly appropriate for rice cultivation under the many small reservoirs scattered across the agricultural landscape in various parts of Andhra Pradesh. The poverty program plans to renovate 2,000-3,000 tanks in the next few years and can introduce SRI there with the facilitation of NGOs.

### Meeting of SRI Stakeholders at ANGRAU

Saturday morning, I went out to the Andhra Pradesh agricultural university to meet the Dean of the Agriculture Faculty, **Dr. M. Sudarshan Reddy**, at 9:00. He is currently also acting Director of Extension. He said that he has himself used SRI methods and is very pleased with them. He apologized that he could not spend the day with us in the planned meeting because he has to participate in the AP Department of Agriculture's annual planning meeting for the upcoming rabi season. He showed me the background paper that had been prepared for the meeting.

In its section on SRI, the Agriculture Department paper presented statistics summarized below:

	Standard Practice	SRI	Differences
Costs of production (Rs./acre)	8,000	7,500	<i>Reduction of 6.3%</i>
Water requirements (liters/kg)	1,200	750-850	350-450 liter saving <i>Reduction of 30-37.5%</i>
Yield (kg/ha)	5.56	6.81	22.5% increase <i>The report said the increase was 31%*</i>

*\*Other data showed conventional yield = 5,250 kg/ha; SRI yield = 7,350 kg/ha, a 40% increase*

Last rabi season, according to the report, there were 2,150 SRI demonstrations. This season, 12,242 SRI demonstrations are planned, a five-fold increase, at a cost of 218,000 lakhs of rupees.

In the section on ‘Accomplishments’ of the preceding year, the Department reported that the highest total agricultural production yet had been achieved -- at the same time that there was a *40% reduction in pesticide use*, in terms of expenditure. Colleagues later explained that this number overstates the actual reduction in pesticide application because there has been some switching from less effective to more effective (more toxic) chemicals, a qualitative change not reflected in rupee figures. Still, this is a huge one-year decline, showing in another way how reducing inputs can lead to more production. It is hard to imagine five or ten years ago that the Department of Agriculture would express satisfaction in a *reduced* use of agrochemicals, after decades of promoting their use.

The Dean and I tried to figure out how it might be possible for me make a short presentation on SRI to the state’s agricultural leadership assembled that day for the rabi planning meeting. Reddy was certain that this would be welcomed by the Director of Agriculture who is now quite positive about SRI, he said. But to attend the meeting, I would have had to miss part of the forum that had been convened at ANGRAU that morning and afternoon, to take advantage of my visit to Andhra Pradesh. So we let this possibility drop.

The Dean opened the meeting at 10 o’clock, endorsing SRI use and also underscoring that much systematic research is still needed on this, including on varietal effects. He reminded the group that a recent report from the government’s National Commission on Farmers headed by Dr. M. S. Swaminathan had said that 66% of farmers in India have less than 1 hectare of land (2.5 acres). “We need to think of technological improvements that are relevant to these farmers.” He said further that the state’s Chief Minister is very convinced about SRI, advising farmers to use the methods because they can save water and get more yield at the same time.

The Registrar of ANGRAU, **Dr. Dandu Jagannadha Raju**, spoke next. He has worked with SRI since it was first introduced in Andhra Pradesh in 2003 because he was at that time head of ANGRAU’s extension center at Oondi in the Godavari delta. He has used the methods himself and said that “Farmers once they see SRI, they are very much convinced. . . it has been proved beyond anybody’s doubt.” He acknowledged that acceptance has been slow among agricultural technicians, however; fortunately, the state’s politicians who listen to farmers are very positive.

The usual practice, Raju said, is for something to be tested first by scientists and then given to the extension service to take to farmers. “But in this case, farmers are convinced, and also the politicians, but not the Department of Agriculture. Fortunately, that is changing.” He said that it has been possible to prove the value of SRI thanks to myself and WWF. He said that we need not worry about how much SRI can increase yield at the maximum; “even getting 1 ton per hectare added yield is very good. Nothing else can do so well, especially because we are saving water. Now we need to address the practical problems of SRI’s use and extension.”

**Prof. Vijaya Khader**, Dean of Home Science and former Director of Expansion, also spoke in the opening session, expressing her satisfaction with SRI and also her interest in its ability to

raise the yield of traditional rice varieties. She invited me to participate in a national symposium on indigenous foods being held at Hyderabad in November at the same time as the planned all-India SRI symposium. We are encouraging farmers to conserve their indigenous rice varieties, in part for the nutritional value that these may have. With SRI, local varieties can give much higher yields, and they can be more profitable for farmers to grow when using SRI methods.

Dr. Khader noted that there were no women farmers attending the meeting, even though women do nearly 80% of rice work. Not only must they do the most work, but they are also usually the most malnourished, she reminded the men in attendance. She was concerned that the development of implements for SRI, especially weeders, should take account women's different physiques and be suited to their particular strengths. I made a note of this for our planned project with WASSAN to evaluate different models of weeders, to make sure that women farmers are involved in the testing and assessment of the various models.

The first farmer to speak was **Krishna Rao**, whose farm is actually in the state of Karnataka, but he learned about SRI from Satyanarayana and has participated in many Andhra Pradesh forums. This season he has expanded his SRI cultivation to 80 acres (>30 ha). He commented on the advantages of reducing the seed rate with SRI from 20-30 kg/acre to just 2 kg. "Think of how many crores of tons of rice can be saved in India if we change over to SRI methods." He cautioned that we should calculate yields from the harvested amounts from whole fields, not just from 1 m<sup>2</sup> crop cuts. He also said that spacing should be varied according to whether one is planting short-, medium- or long-duration varieties; 25x25 cm<sup>2</sup> will not be optimal for all fields.

Another farmer from Karnataka spoke next, saying that most farmers are afraid of SRI when they first hear about it. "They do not have confidence." He said that preparation of the seedbed is of particular importance, encouraging simple methods, saying also that farmers often have very high expectations of SRI and are then frustrated if these are disappointed. He suggested telling farmers that they can get a 20% increase in yield with SRI, and then they will be pleased when this is surpassed. He asked a question to me: why is SRI not spreading? I responded that this is a misperception, although the spread is not the same everywhere. I gave figures from Cambodia, where SRI use has grown from 28 farmers in 2000 to >55,000 households as of March, 2006. This is where we have the most complete numbers and now have active government support.

**Prasad** from East Godavari district said that he had started with 50 cents (half a hectare) because he had labor constraints. But now the labor requirements have come down, now that the methods are familiar, and he also gets more yield. But he said that SRI is benefiting millers most, because SRI paddy gives them a much higher outturn. (We have information from China, Cuba, India and Sri Lanka suggesting that there is about a 15% higher outturn of milled rice from a bushel of SRI paddy.) He said that farmers should get a higher price for their SRI paddy. He has been using SRI methods on 20 acres for the past 3 years. His yield increase is only about 20%, but he is quite satisfied with this because his costs are reduced. Also, his laborers are now acquainted with SRI methods, so they have no problems using them.

**Janakaramaya** from Anantpur district said that he also has 20 acres of SRI. His innovation has been to assign one acre of land to each of 20 groups of laborers each does all the operations on their respective assigned areas. They are producing 60 bags/acre (11.25 t/ha) of paddy. This

management approach is good for the laborers and good for the landowner. He was asked about fertilizer use and said that he is still using some chemical fertilizer, along with organic inputs, 25-40 bags/acre (costing 4000 Rs./acre).

**Shauri Reddy** from Warangal district said that he is getting at least 40 bags/acre where he used to get 30-35 bags. His major problem is weeding. At first, he was using 20 laborers for half an acre, which was too expensive. The Agriculture Department supplied him with a marker to facilitate transplanting, but this was not of good quality. He went back to using sticks and strings, and laborers found this easy. He emphasized that the government and NGOs when publicizing SRI should be sure they are giving correct information, e.g., how much labor is needed for each operation. “Don’t be misleading,” he said. He also advocated presenting more variability within the system. “Don’t say just one seedling; be flexible. How young should the seedlings be? That should be flexible too.”

**Kyedukondahl**, a schoolteacher who runs his own school and also practices agriculture, said that he is in his second year of SRI practice. He uses MTU 1010 variety and broadcasts instead of transplanting, then weeds three times. He gets 210-250 grains per panicle and said that the stems (tillers) are very strong with SRI cultivation compared to normal practice.

**Yedi Reddy** from Nalgonda district, looking both young and energetic, introduced himself as “a first-time SRI farmer.” He said that his cost of fertilizer is now less, and water is less. Weeding is done very 15 days. He gets 57 bags harvest where he got 38 bags before, a 50% increase. He needs only four persons to transplant his  $\frac{3}{4}$  acre, so can rely on family labor. He has encouraged 20 other farmers to take up SRI, demonstrating that the methods are easier than usual cultivation. He said that he weeds his crop by himself with a rotary hoe, and he is ready to train more farmers.

**Narasimha Reddy** from Mahbubnagar district plants 13-day seedlings in rabi season, a short-duration variety, and needs 15 laborers for transplanting. He weeds every 10 days, but the weeder that he has is hard to use. If a better weeder is provided, he could manage a larger area. Grain filling is very good. With his previous methods – planting 20-day seedlings, 4-5 per hill – the tillering was considerably less.

**Venkateswara Rao** from Guntur district has 7 acres under SRI. His first year he got 28 bags per acre the first year, 24 bags the second, and 30 the third year. His usual yield had been 14-15 bags. He suggested that instead of going for the full set of practices, why not just go for one seedling per hill and reduced age of seedlings? This would simplify things. Krishna Rao asked for Rao’s cell phone number, saying that he would like to discuss this matter further.

**Narsa Reddy** from Nalgonda district said that he has only half an acre of paddy land, and he is getting 4 bags higher yield with SRI methods (0.3 t/ha). He has no problems with the methods, and his cost of cultivation is less. He waters his rice crop with lift irrigation, so he can maintain a good crop standing even if there is no water for 4-5 days.

**Suresh Kumar Reddy** from Ranga Reddy district said that this is his fourth time using SRI. The water saved has enabled him to expand his area, and he is now practicing 100% organic agriculture. SRI presents problems in the rabi (winter) season because of water shortages.

Having access to a good weeder is also a problem. There should be more SRI demonstrations at village level, he said. He has gotten 55 bags/acre compared to 40 bags before. Training is important, because “most farmers are still not aware about the details of SRI.”

**Narinder Reddy** from Medak district said that he is getting 30-32 quintals/acre (7.85 t/ha) compared to 18-20 quintals before, 63% more. He is still using weedicides because mechanical weeders are not available. Interestingly, his grain weight is much increased, he reported. Bags that used to hold 60 kg of paddy rice now weigh 80 kg. The grain panicles are nice and uniform, he said. His transplanters are now able to set out young seedlings in a square pattern as desired without using a marker, just by eye sight. Now he wants to try direct seeding.

**Rangana** from Mahboobnagar district reported that he finds using the weeder difficult. He has only ¼ acre under SRI, so this is surprising. His seed rate is only 4 kg/acre (10 kg/ha), and his observation was that SRI is much better for small farmers, who do their own work, than for big farmers.

**Praveen Reddy** from Kurnool district commented that SRI methods can give higher yield on both red and black soils. When the seedling age is greater, there is need to reduce spacing, but with more seedlings and narrower spacing, he can match his SRI yield. He recommended that the SRI practices be introduced one by one, so that farmers do not become scared. He did understand the importance of wider spacing, explaining that with crowding there is competition for nutrients. SRI spacing gives better growth, he concluded.

**Kishan Rao** from WASSAN was introduced next as a practicing SRI farmer, which he is. He started with 1 acre of SRI the first year, and has now gone to fully organic production. He gets 12 bags/acre on black soil (2.25 t/ha) and 24 bags on red soil (4.5 t/ha). This supports our observation that the best soil for SRI is not necessarily the low-lying clay soils that have historically been deemed ‘good for rice.’ However, his soil seems is less fertile than others’.

**Nagaratnam Naidu** from Ranga Reddy district talked about his use of SRI methods with a basmati variety. He has gotten up to 142 tillers on a plant, and finds that once the roots are established, the plants can last 10-15 days without water. This is partly because he used farmyard manure and organic matter to increase the soil’s water-holding capacity. He hasn’t harvested this year’s crop, but he expects a higher yield than before.

**Satyanarayana** from Guntur district said he has 4 acres under SRI. Everyone discouraged him at first, he said. There was a problem with the weeder he was given, but he has modified the design, and it works better now. SRI will help increase production of good-quality rice, he is convinced.

Next the floor was given to researchers and rice specialists. **Dr. Venu Gopal**, coordinator of the DAATC at Mahbubnagar, reported, saying the SRI promotion has been difficult in East Godavari because irrigation there is mostly through field-to-field flows, and there are drainage problems. Water is not well controlled. “Let us be frank,” he said, “it is slowly picking up. Water control is the main problem. But farmers who are doing this cultivation are very happy with it.”

**Dr. Shushi Bhushan**, who has worked with farmers on extrapolating SRI concepts to sugar cane production, said that he started working with SRI in 2003, when Dr. Satyanarayana introduced it in AP. There are problems with using young plants in the rabi season, when temperatures are low. But one farmer in his area has gotten a yield of 16.2 t/ha, showing the potential the methods have.

Efforts to promote SRI in a bureaucratic way are not succeeding. Where DAATC directors are working with farmers, they are taking up SRI partly to please the directors. In one place where there was a 1,200-acre target, only 150 acres were actually planted, and the weeders provided by government are lying unused in the go-down. Many factors are important: nursery management, and having weeders appropriate for heavy soil are critical, Bhushan said. On the other hand, with SRI methods, there is less disease, he said, and the tillers are strong and the panicles large.

**Dr. P. Nageshwar Rao**, coordinator of the DAATC for Ranga Reddy, said that SRI is spreading very fast there, now used on over 2000 ha, more than 10% of the paddy area. In some places, entire villages are using SRI, with an extent of 300-400 hectares. He mentioned Belakatore near Tandoor as a good example. 95% of irrigation is done from boreholes, so this creates a strong incentive to save water and also gives farmers a capacity to control water application.

Yields of 55-60 bags/acre are being achieved (>11 t/ha), where yields used to be 30-35 bags, and pest and disease problems are less with SRI. “Simply by seeing these things, farmers have adapted these practices to their own needs and are now enjoying the fruits.” At first, farmers thought the higher yields and better health of crops were due to a change in variety. “I got phone calls asking me for ‘SRI rice’.” The main constraint, he said, still is the design and availability of conoweeders. There are also labor constraints, as many farmers do not find it possible to do four weedings as recommended. A big improvement would be to develop mechanized weeders. When Rao sat down, another official vouched for what had been reported about whole-village adoption; “I have seen the village,” the official averred.

We were past the time for lunch break, so the meeting adjourned to the ANGRAU guesthouse. During this time, I spoke with Dr. Bhushan, whom I had met first during the visit in 2005. He reported that the farmer who had first applied SRI concepts to sugar cane production, Prabhakar Reddy, and who got 100 tons/acre the first year, tripling his usual yield, had gotten 110 tons/acre the second year. I asked Bhushan for a written report on this experience so that it could be incorporated into an article on extrapolation of SRI to other crops, with him as a co-author.

I spoke also with Nagaratnam Naidu, a farmer who has been a frequent spokesperson for SRI in the state. He briefed the AP Chief Minister on SRI (see URL given on page 1, paragraph 5), and also President George W. Bush when he visited ANGRAU in March, 2006. He said that he has gotten a yield >15 t/ha with SRI (though not every year) and that has personally trained >1,500 farmers on SRI.

When the meeting reconvened, a number of research scientists were invited to share their experience and ideas. The first, from Nandiala Research Station, said that at first he had not practiced SRI because of non-availability of labor. But then he got a yield of 85 bags/acre (15 t/ha) his first year. The second-year yield was lower, 65 bags/acre, and one farmer who tried the methods had only 30 bags, his crop having been affected by a lack of sunshine during the

panicle-setting period. Weeding remains a problem. A 6-row power-operated weeder weighing 85 kg was brought to his station and tried out, but it was too heavy for the black soils and kept sinking into the soil and getting clogged. It has a ½ horsepower engine that runs on petrol, but this is not yet practical.

This discussion of weeders prompted **Dr. Aum Sharma** from the agricultural engineering department of ANGRAU to speak next. He described his efforts to improve the design of conoweeders and markers. Not everyone agreed with his claim that these were developed at ANGRAU, as he claimed, but it is clear that a number of designs are needed to suit different conditions. The big challenge is to ensure local availability (also of spare parts) and at affordable prices. Weeders and markers are easier to use and last longer when they have bearings installed for the moving (turning) parts. This adds to their cost -- although one farmer, K.V. Rao, says that the cost of bearings, if purchased in bulk, can be brought from 20 rupees down to 7 rupees.

The tradeoff between low cost and long life is a real one. There is enough improvement in labor-saving and crop performance to justify making a greater initial investment to have quality implements to work with. The next advance in design will be motorization. Sharma has built a 4-row motorized weeder with a diesel engine of local manufacture. However, it weights 14 kg and is too heavy for some soils. A single-row Japanese weeder with a Komatsu engine that he had evaluated was not suitable for SRI use, he said.

When my time came to make a presentation on SRI in response to what I had heard and learned from others' reports, I focused on the results of factorial trials done in Madagascar done in 2000 and 2001 by honor students in the Faculty of Agriculture at the University of Antananarivo. These two sets of trials (N=288 and N=240) used randomized plot design to evaluate different combinations of practices and assessed SRI performance in two contrasting agroecosystems: sea level, poor sandy soils, tropical climate vs. 1,200 m elevation, better clay and loam soils, temperate climate. The question had been raised: why can't SRI be simplified so that farmers need to make only 2 or 3 changes in their current practices?

My answer was that farmers can make as many or as few changes as they want to. If farmers use fewer SRI practices, they will forgo some increase in potential yield. Each practice confers some benefit; all done together confer the most benefit. Factorial trials have showed us was that there is synergy among practices; while doing any of them adds to yield, doing all together adds the most.

In the factorial trials, using the full set of practices (young, single seedlings, with aerated soil and compost) gave 2.4 times more yield on poor soils and >3 times more yield on better soils compared with conventional practice (older, multiple seedlings, with saturated soil and NPK fertilizer). These conclusions were based on replicated trials, with each average based on 6 replications.

The choice of what to do is always up to the farmer, I emphasized, suggesting that we explain to farmers -- with as much reliable evidence as we can assemble -- what are the effects of different practices, individually and collectively. The forum adjourned at 4:00, well beyond the original scheduled time because there was so much interest and a lot of experience to be shared. Kishan

and I visited Dr. Sharma's workshop on the edge of the ANGRAU campus on our way to the headquarters of ICAR's Directorate of Rice Research, also located near the campus.

The DRR project director, **Dr. B. C. Viraktamath**, who is also chair of the Local Organizing Committee for the planned November SRI symposium, met us in his office, and we spoke from 5 until 6, first about the symposium and then more generally about SRI and the agricultural research enterprise. His experience with SRI has been very positive, and he is one of the few senior rice researchers in the country who has actually gone out into the field to see SRI results and to talk with SRI farmers. The November event should help reduce any disagreements still remaining within the Indian research establishment on the merits of SRI. That evening we had a nice Indian dinner with ANGRAU and WWF colleagues.

### **Plans for Improving Weeder Designs and Access**

The next day had been mostly unscheduled so that I could go to the new home of Satyanarayana for a delicious lunch prepared by his wife and then visit his new office nearby at Nizuveedu Seed Co. Ltd. When turning to the ANGRAU resthouse, I met with Kishan, Ravi and Ramoo from WASSAN and CSA. One topic was a possible collaborative effort to do systematic evaluation of weeder designs. During the preceding days, farmers and others had often mentioned that lack of weeders, or lack of well-designed weeders, was an obstacle to the spread and effective use of SRI. Shortly before my trip, David Galloway, an SRI supporter living in Canada, had told me that he could provide us with \$10,000 to improve the practice of SRI around the world. How could this be best used?

It seemed that what is most needed at present is to bring together as many different models of weeders used for SRI as we can find, and to have them evaluated in a systematic way by farmers, both men and women. The ease of operation, effectiveness of weed control, durability, cost, etc. should be widely and reliably known about different weeders. Those judged to have the best features should be photographed, and technical drawings should be made of them, so that pictures and blueprints can be posted on the web. That way, anyone in the world can download these to use for local fabrication. WASSAN already maintains a very good web page on weeders and markets ([http://www.wassan.org/sri/Weeders\\_Equipments.htm](http://www.wassan.org/sri/Weeders_Equipments.htm)). With modest resources, this could be expanded upon to include the results of farmers' and technicians' evaluations for many more weeders. We discussed how such a project could be carried out before adjourning for supper.

### **2<sup>nd</sup> International Rice Congress**

The next morning, Monday, I traveled back to New Delhi for the Congress, which is reported on separately. These five days were very fruitful both for learning about SRI experience in India and other countries, and for sharing knowledge about SRI with interested persons. But this is covered in the other report [URL]. It was indicative of the progress made with SRI since my previous visit to India that I while in the airport Friday evening, waiting for my flight to Bangalore, by sheer and wonderful coincidence, I met **Dr. M. C. Diwakar**, project director for ICAR's Directorate of Rice Development (DRD) in Cuttack, Orissa State. He is the counterpart of the DRR's project director, Dr. Viraktamath, whom I met in Hyderabad on the 7<sup>th</sup> and saw again at the Congress in New Delhi.

We were both sitting in the departure lounge when we noticed each other and sat together. He reiterated what he had said briefly when we first met at the Congress on Monday. He had been able to visit SRI fields a number of times in the north of India, and he had seen ‘the SRI effect’ which we talk about in the literature and on our web page. He is satisfied that these methods have a lot of promise for Indian rice production, and especially for the millions of smallholding farmers who have not been able to benefit from Green Revolution technologies.

There is still a lot of research and evaluation and fine-tuning to be done before SRI is utilized to best and broadest effect. But there is no need to hold back dissemination efforts. Farmers are already spreading SRI on their own. Diwakar emphasized the value of farmers and researchers working together to better understand and improve SRI methods. I was not accustomed to such perspectives from senior Indian scientists, so this bodes well for the future of Indian agriculture.

## **KARNATAKA STATE**

In Bangalore that evening, I was met at the airport by **Dr. Arun Balamatti**, executive director of the **Agriculture-Man-Environment Foundation (AME)**, which was one of my hosts for this visit to Karnataka State. The president of AME is **Dr. R. Dwarakinath**, a Cornell alumnus who after completing his PhD in 1973 subsequently became the state’s Director of Agriculture and then the Vice-Chancellor of its University of Agricultural Sciences. After retirement as VC, he served as an FAO consultant in Indonesia for a while, and then upon returning to Karnataka, he applied his energies and expertise to agricultural and rural development for disadvantaged households and communities through AME and other NGO channels. My other host was **The Green Foundation (GF)**, whose executive director **Dr. Vanaja Ramprasad** I met in September 2004 at an Eco-Agriculture conference held at ICRAF in Nairobi. GF had already begun promoting SRI in some of the poor rural communities where it works, with good results, so Vanaja and I were immediately befriended. Given that AME and GF were already cooperating because their missions are quite convergent, there were no problems with this dual hosting.

## **Village Visits**

My Saturday program was arranged by staff of the **University of Agricultural Sciences** who picked me up at 8:30 to visit a number of villages outside of Bangalore where it has been introducing a version of SRI called ‘semi-irrigated production’ (SIP) through a Tank Restoration Project that it is managing with World Bank and other funding. My traveling companions were **Dr. Nagaraj** from the Department of Agricultural Extension and **Gubbiah**, a consultant for the tank restoration project. The first leg of our trip took two-and-a-half hours over a variety of roads.

The first village visited was **Chikakalahalli**, just 4 km from the border with Tamil Nadu. We were met by a large gathering of farmers, who had arranged for drum-beating and garlanding in the grand village style. At one point in our walk around the paddies, a group of girls and an older woman stopped me to sing a traditional welcome and place a dripping red *tikka* on my forehead. Most of the SRI plots were doing quite well despite the lack of rainfall this year. When we uprooted an SRI plant to compare its roots with those of a conventionally-grown plant, the difference was dramatic and instructive, almost stereotypical. One farmer commented that with these new methods, one-quarter acre of good paddy land can be enough to feed a whole family (see Picture 1 in Trip Report picture file).

One interesting thing the farmers showed me was their experimentation with cover crops to control or suppress weeds. Cilantro, for example, has allelopathic effect on weeds and at the same time is a good crop to grow for supplementary income. In a shady spot beside one field, I was shown a drum-seeder that can directly seed five rows of rice at a time. The width between rows can be adjusted, and by putting tape over holes in the respective bins, the distance between hills can be regulated. Most seeding is being done at 30x30 cm, but other spacings are possible. Farmers are generally satisfied with their direct-seeding experience so far, although weed control remains the factor most affecting success (Picture 2).

One young farmer who used the new methods last season was told by his father and grandfather that he had “disgraced the family” with such an innovation. However, by the 50<sup>th</sup> day of crop growth, the grandfather was convinced of the methods’ merits, he said, and when they got a yield 1 ton/ha higher than before, there was no more tension in the family. Root grubs were mentioned as a problem by one farmer, but another said that these can be controlled with use of neem cake.

As we were finishing our observation of the paddies, the Member of Legislative Assembly (MLA) who represents this area in the state parliament arrived to join us. I explained to him the reasons for the differences between root systems and their implications for plant health and performance. He did not appear to have much farming experience, but he was enthused by what he saw and heard, not just from me but from farmers. His offer to legislate the use of SRI methods, however, we discouraged as politely as possible. I suggested that farm practices need to be decided on by farmers for themselves, since they are the ones who live with the consequences.

At **Sathahalli**, the second village that we visited, a young farmer and his mother who were growing SRI for the first time met us, being soon joined by other villagers. Their field looked quite good, but it was not far enough along to know what the yield would be. I asked what was the most difficult part of doing SRI and was told: weed control – “but with the mechanical weeder this is now relatively easier.” They said that overall, the amount of labor required when using the new methods is less (picture 3).

A farmer who joined us said that he had done SRI the previous year, but this year he could not do so because of a lack of water to start the crop, this being a drought year. He has tried several different methods of direct seeding and transplanting and said that SRI can save both labor and seed and has less pest and disease problems. His SRI plants had as many as 80 tillers last year. The seedling age used was 20 days because “it was difficult to get the laborers to plant seedlings any younger.” I told him this means that there is scope for still further yield improvement once farmers and laborers gain more confidence in the methods and use younger seedlings. This farmer said he had tried out 25 varieties with SRI methods, including 5 or 6 local ones, and he found that all but one of them resisted lodging.

We walked to a neighbor’s field where SRI is being used with several varieties, KRH-2 and Suruchi, a hybrid. The farmer here have found that blast, which is a problem with farmers’ practice, has not emerged as problem so far with SRI practices. Root grubs have emerged in some places, but they are not a major problem, I was told. (When we visited Narayan Reddy the next day, he delineated a biological management strategy for controlling this pest.)

At **Dypasandra**, we visited a farmer who is using plastic trays shaped like mini-egg cartons to raise his young seedlings for SRI. Such ‘root trainers’ are becoming common for horticulture. There is no root disturbance when transplanting the soil plug in which the young root is growing. A tray with 198 cells is available for 21 rupees in the market (<50 cents), and it can be used many times (Picture 4). This farmer is also experimenting with ‘dibbling’ (direct-seeding) of rice seeds. Last year, he harvested 30 quintals/acre (7.5 t/ha), and he said that his labor requirements were less. His average number of tillers was 62, with a range from 32 to 75. On the way back to the car, he refreshed us with fresh coconuts at his house alongside the road.

Then, at the fourth village visited that afternoon, **Gulagangigurki**, we talked with a half dozen farmers who are practicing SRI. They were using a ridge-and-furrow system that improves soil aeration and water control, using three varieties: KRH-2, Sonalika, and a fine-rice hybrid Theanu. At 60 days after transplanting, the KRH-2 plants had 55-66 tillers, while Theanu plants had 45 tillers; Sonalika numbers were in between.

I asked the women who were with us, colorfully dressed in their saris and bangles, what was their experience with the new methods? They responded that the new methods are very good, “but this year there is a lack of rain.” The results would be better if there had been more rain, they said, however, “these are better methods.” They added that other persons have come 4 to 5 times each week to look at their crop. “We can explain very well,” they said with impressive self-confidence, perhaps the result of their farmer field school experience (Picture 5).

I asked again specifically: how do women evaluate SRI? They ticked off four points: less water, less labor, less seed (they said that for the field in front of us, seed had been reduced from 12 kg to  $\frac{3}{4}$  kg), and “less drudgery.” This last point was not expected and was the most welcome feature to hear about. We discussed why the SRI plants perform better, including the importance of aerated soil “so that plant roots can breathe.” The women were able to amplify each of the points that I tried to make simply, indicating that the farmer field school training they received had been effective. “All we need is more rain,” they said plaintively.

Having passed mid-afternoon and needing to get back to Bangalore for a dinner that evening, we left the village and drove back to a main road, stopping for a lunch about 4 o’clock on the way back to the city. That evening, Dwarakinath hosted a splendid dinner with members of AME’s board of directors, discussing agroecology, SRI and other matters. It was good to find such an experienced group of agriculturalists and development specialists so dedicated to development particularly of disadvantaged rainfed areas of the state. This year communities in these areas are suffering more than usual hardship because of the failure of the rains, something becoming the norm rather than an exception.

### **A Visit to Narayan Reddy’s Farm**

On Sunday morning, Arun from AME picked me up at 8:30, together with **Krishna Prasad**, AME board member and editor of *LEISA-India* magazine. We drove an hour and a half to the village of Maralenahalli in Doddaballapura Taluk, near Hanabe town, to the farm of the first farmer in Karnataka to try out SRI, **Narayan Reddy**. He has been practicing organic farming for over 20 years and writes a regular column for *LEISA-India*. We had met previously at a

conference in Tamil Nadu in October, 2003. He told me and others then that SRI was the most exciting innovation that he has encountered in all his years of farming.

Arun told me something of Narayan Reddy's history before we arrived at the farm. As a young man, Narayan Reddy worked as a restaurant worker for many years, saving up a few rupees each week until he could buy himself some land. He passionately wanted to make farming his life's work. At first, he threw himself vigorously into 'modern' agriculture, winning several prizes for the best performance in the district with his input-intensive agriculture. However, he began to pay attention to his rising costs and shrinking net income. Finally, through acquaintance with an American visitor, identified only as a former NASA employee, he decided to make a new start using organic methods. This person "opened my eyes" to the alternative of organic agriculture, he said, becoming both an effective practitioner and an articulate promoter of this.

Lacking university education, Narayan Reddy is a self-taught agronomist, casually reeling off facts and figures on soil nutrient composition, maturation dates, and other technical matters. He is now over 70, but still travels widely, speaking and advising as one of the best-known 'gurus' on organic farming. When I was at ICRISAT, O.P. Rupela told me that Narayan Reddy has just served as a resource person for a training program at ICRISAT on biological approaches to crop production and protection.

When we arrived at the farm and got out of the car, Narayan Reddy greeted us. Prasad asked him about the clumps of human hair all around on the ground. Those keep away wild boars, which are a problem in the area, we were told. "The hair needs to be replenished every 20 days or so because rain washes away the scent that the animals dislike."

By his own account, Narayan Reddy has become reasonably prosperous over the years, but he lives simply and traditionally, putting what earnings he can spare into buying more land. He has now several other landholdings, operated by other members of the family. The farm that he showed us around was practically bare of trees when he started farming it 12 years ago. (When back in his house, he showed us pictures of the farmland when it was purchased.) Now he has 48 varieties of trees on the farm, producing various products and contributing certain services to the agroecosystem he has fashioned.

One of his current campaigns is to get farmers to switch back to indigenous cattle breeds. The improved Holstein crosses have better milk production, but they continue to be more susceptible to diseases, and they require better quality (more expensive) feed. Narayan Reddy insists that when all costs and benefits are reckoned, local breeds perform better economically. Among other things, the exotic crosses have shorter tails and are thus less able to keep flies off themselves.

Narayan Reddy is an active promoter of SRI, having popularized the methods thus far in six states: Karnataka, Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Chattisgarh and Orissa. He is making modifications in standard SRI practice to use the concepts for unirrigated (rainfed) production. This involves direct sowing of seeds, using 6 kg/acre rather than 2 kg, with some thinning out once they have sprouted. He mixes germinated seeds with sand to make sowing easier. This is done at the time of the first rain or water issue. This can move up the crop season by as much as 6 weeks because normally farmers begin their land preparation at that time. He

says that his version of SRI is giving better yields than Andhra Pradesh farmers get with irrigation, 500 kg of NPK, 100 kg of urea, and 50 kg of Furudan, a systemic insecticide. Moreover, using these inputs makes the soil saline over time.

Germination is promoted by soaking the seeds in what is called “a nectar” in Kannada language. He mixes together (in a clay pot or plastic bucket, not a metal container) 2 kg of cow dung, 2 liters of cow urine, and 10 liters of water, plus some calcium carbonate that serves to suppress seed-borne diseases, assuring healthy seedlings. As we spoke, a young farmer from Tamil Nadu arrived, Venkataraja, who has become a kind of understudy for Narayan Reddy, often coming to spend weekends with him, listening and learning.

Narayan Reddy said that SRI methods make the soil better, and they save water. “If all farmers would take up SRI, we could deal better with our inter-state water disputes.” The only problem is weed control, he says. He does one weeding by hand and then uses a soil-aerating weeder. Last year he found that doing 8 weedings rather than 2 weedings added 1 ton/ha to yield, making the effort worthwhile. On soil improvement, he said that his neighbor’s soil tests 0.5% carbon, while his is now 2.89% C. With organic matter in the soil, this reduces soil water requirements, i.e., what must be provided externally. Each kilogram of soil carbon increases soil water-holding capacity by 8 liters, he added.

He talked enthusiastically about the contributions that trees make to farming systems, saying that 35% of all farmland should be devoted to trees of diverse varieties, providing various products and shade as well as organic matter for the soil through leaf litter. They serve as nutrient pumps from lower soil horizons and are also important as windbreaks. The temperature in his garden (as he refers to his farm) is 2 degrees C lower in summer and 1 degree C higher in winter, thanks to trees.

When I told him about seeing leguminous trees used in Ghana to reclaim soil that was practically ‘dead’ due to compaction and loss of soil organisms, keeping it aerated and making the soil fertile, I commented that farmers there had found leucaena to be a problem because of its weediness. He dismissed this as a matter of management. “If one cuts the flowers or seed pods off leucaena, unwanted spread can be prevented,” he said. He added that the belief that feeding leucaena leaves to cattle or sheep causes loss of hair (depilation) is mistaken, citing his own experience to the contrary.

I asked how he learned about SRI. He said that he read about it from reading our first article on SRI (*LEISA Magazine*, 1999) while visiting the Netherlands in 2001. He is interested to refine direct-seeding versions of SRI, adding that these might not be suitable for some clay soils, however (Picture 6).

Narayan Reddy told us about a neighbor, a 70-year-old widow who has taken up SRI on 18 acres, with many different varieties. The first year, her crop was beautiful but was ruined by wild boars. Spreading human hair around her fields took care of that problem, but the second year there was too much rain. The problem of flooding she remedied by making drains within her fields and using a pump. Now this year she has a fine crop, with many plants having 70 tillers or more, and a hybrid variety reaching 110 tillers.

As we walked around the farm, Narayan Reddy took us past a big concrete vat where he prepares a decoction to enhance soil and plant performance. Ten liters of cow manure and 10 liters of cow urine are combined with 2 kg of jaggery (raw sugar), 2 kg of wheat flour, 2 kg of leguminous flour, plus a handful of topsoil (from an anthill). Between 50 and 200 liters of water are added to dilute this mixture, which is left in the shade for three days, being stirred several times a day for 5-10 minute. This is then applied with the irrigation water or spread on the soil. Tests have shown that this enhances beneficial soil organisms including trichoderma, pseudomonas, lactobacillus, and actinomycetes.

We walked to and then into Narayan Reddy's SRI plots, growing very nicely. He said that rains have been poor for the last five years, except last year. With SRI he has cut his electricity costs for irrigation by about 2/3, though the exact amount depends on rainfall. In 2005-06, with good rain, he used only 200 units of electricity (compared with 4000 before). His SRI yields have always at least been double his previous yield, and he expects his yield this year to be the best yet.

One difference between SRI and conventional methods, he noted in the field, was that rats used to get about 15% of his yield. Everyone thought that flooding fields deterred this pest, but not really. With the wider spacing of SRI, he finds that they leave his rice fields alone, even though the soil is dry. They don't like they open spacing. (This has been reported by other SRI farmers.)

Root grubs can be a problem with SRI when fields are not kept flooded, but he says he knows how to keep them in check. First, he does manual digging to remove them. He feeds them to his chickens, as they are a good source of protein, so this repays him for his effort. Then he floods his field for 2-3 days continuously to drown them. If they are still a problem, he applies a biological control agent, *Bacillus thurengiensis* (Bt). He learned about this from a Rodale publication and uses just 4 kg of mixture per acre.

Narayan Reddy has also tried SRI concepts with maize and ragi (finger millet). With the latter, he has gotten up to 23 quintals/acre (5.75tons/ha). Usual yields are usually in the 5-10 quintal range, so this is a large increase. He said also that the SRI paddy he grows is considerably heavier. He didn't have any grain-weight figures on this, but he said that a bag which normally holds 75 kg of paddy weighs 85 kg with SRI paddy, about a 12.5% gain in grain density. This contributes to a higher rate of outturn for milled rice.

So far he has trained at least 1,500 farmers in his area on SRI methods, and he has participated in the training programs of institutions farther away. In the state of Chattisgarh, the Chief Minister came to see the SRI plots of the farmers whom he trained, and witnessed a doubled yield. Now one-third of the farmers in that district are using SRI. Narayan Reddy invited us to stay for a lunch prepared by his wife, and as we were getting ready to eat, the Director of Horticulture for Karnataka state dropped in with his family. He was introduced as a strong proponent of organic methods now for this sector, and Narayan Reddy is helping with training.

The lunch, eaten from banana leaves in the traditional manner, was delicious, preparing us for the rest of the day's program, which included a three-hour drive over some very poor roads to

reach the Karnataka State border with Andhra Pradesh, crossing into AP, to visit a region where AME has a watershed management program in which SRI has been introduced. Arun apologized that we had to drive so far to find a cluster of SRI fields and SRI farmers to visit, but this is a drought year. Many farmers who were willing to use the new methods, based on seeing the previous year's performance, had backed off when there were no rains. All rice production in AP and Karnataka has been diminished, not just SRI.

### **SRI in a Dryland Village**

We reached **Kolimirallapalli** village about 4 o'clock, accompanied by three AME staff members whom we met up with in the town of Amadaguru. They support the watershed program in this area which is across the Karnataka state border and actually in Andhra Pradesh. As we walked almost a kilometer to look at the first set of SRI fields, I was told that rainfall this year had been only 400 mm compared with more typical rainfall of 700 mm. All rice crops here must depend on boreholes for their water supply, so there is an incentive to use water sparingly.

The first SRI field we came to was visible from afar because of its strong green color (Picture 7). It belonged to **Nagaraju**, who was using SRI for the first time. Last year, his neighbor **Appaia**, who was also with us although we didn't visit his field, got such good results that others in the village were persuaded to try SRI themselves. Now six farmers here are growing SRI rice on 6.3 acres. All together, 16 farmers in this block are using SRI methods this season, despite the adverse weather conditions.

The seedling age used this year was 17 days, which is the best age according to farmers who planted a range of 12-day to 25-day seedlings last year. Yields last year were increased by 2.25 tons/ha, sufficient to arouse interest. The average number of tillers was 60-62. Already the first-year crop we were looking at had 30 tillers after 40 days in the field, with more tillering to come.

I asked whether they had any pest and disease problems with the SRI crop? Appaia said that these are less because of the wider spacing of plants. "Even rats are less," he said, echoing Narayan Reddy's observation. We walked several hundred meters to the field of **Sivapalreddy**, who is also a first-time SRI user. His crop is younger, just 22 days since transplanting, but growing well. He had not done his first weeding yet because of problems with his weeder, which has been taken for repairs. He cut his seeding rate from 35-40 kg to just 2 kg.

At the next SRI farm which we walked to, managed by **Ramadas**, we saw a large patch of dense, crowded rice plants. This, he explained, had been the nursery, much too large for SRI purposes so the unused seedlings had just been left in place. Ramadas pulled up, at our request, an SRI plant to compare its roots with those of a conventional rice plant. The differences were dramatic, with the SRI roots distinctly larger and whiter. When Ramdas replanted the SRI plant in the conventional plot, everyone could see that it was 10 inches taller than the conventionally-grown plants around it. Ramadas counted tillers, saying that the plants were the same age. The conventional clump, with 5 plants, had 20 tillers; the single SRI plant had 36 (Picture 8).

As walked back to and through the village, to visit some more SRI fields, I looked at a report that the AME team had prepared on their work with SRI in this area around Madanapalli. In kharif season 2005, only 9 farmers in this area tried SRI, supported by various NGOs (Spandana,

APRRM, ACTS and Chaithanya). In rabi season 2005-06, this number expanded with 37 more farmers undertaking SRI on an average of 0.46 acres each. These are small farmers, most of whom are not yet using SRI on their whole extent of paddy land. In this current kharif season, the number of additional farmers is only 14 because of the weather conditions, but their average SRI area is 0.61 acres.

The report contained good color pictures of the different operations, but my eye was drawn to the detailed tables from the first two seasons, showing variety, area sown, age of seedlings, numbers of tillers (productive and unproductive), panicle length, grain yield, and grain weight. Later I calculated averages from these tables. Average SRI yield was 7.96 tons/ha compared with 6.07 tons/ha for the control plots, a 31% increase the first season. The second season of trials/demonstrations, had an average increase of 19.6%.

The SRI field of **Bhaskareddy** was nicely laid out. He said that when Appaia first tried out SRI the previous year, “People criticized him, but now they are eating their words.” Bhaskareddy said he has had no pest or disease problems. The swarms of dragonflies hovering over the field in the setting sun suggested that there was a lot of biological control of insect pests going on. An adjoining field belonging to **Narasimhulu** was also under SRI management. He had not been able to do mechanical weeding, only hand weeding, but the field looked good.

We walked to a high spot near the two fields and sat down for a discussion (Picture 9). The concerns and observations were familiar ones. The first question was: “Which varieties does SRI work best with?” So we discussed the relative contributions of genetic potential and management practices. Their farmer field school training had given them a good understanding of these issues, but even so, there is still an inclination to consider varietal differences as the most important factor to consider.

I asked what are the women’s assessments of SRI, directing this question to the few women with us. Water requirements have been reduced, they said, but they remain worried about weed problems. There is much demand here for having suitable mechanical weeders so that the weed control needed for SRI can be managed. When I asked about the introduction of SRI here in this village, Appaia commented that his own mother had “scolded” him when he started with the methods, and so did the government extension worker. But now they are all happy that he took this initiative. As the sun was almost down and it was a three-hour drive back to Bangalore, we took our leave and walked together back to the car, first returning to Karnataka State and then finally reaching the hotel in Bangalore about 9:30.

### **Another SRI -- The System of Ragi Intensification**

Monday morning started at 5:15 as we had to catch a train leaving Bangalore at 6 a.m. for Haveri in the northern part of Karnataka state. Traveling with me were **Krishna Prasad** from the Green Foundation and **Ravikumar** (Ravi), area unit coordinator for AME. We had long conversations on the six-hour train trip, such as why SRI yields in India have not yet matched what is reported from some other countries. My suggestion was that Indian soils are not just low in soil organic matter, but deficient in abundant and diverse populations of soil organisms.

Continuous heating by the tropical sun raises soil surface temperatures to 50-60 degrees C, possibly even higher, practically sterilizing the top horizon. SRI methods by themselves can raise yields to the 6-8 t/ha range; achieving yields beyond this requires active growth-promotion by soil organisms. I suggested that conventional practices -- flooding, close spacing, etc. -- are keeping rice production 'grounded,' while SRI methods can help farmers achieve the equivalent of 'flight,' making rice production take off. However, these methods are like propeller airplanes that can overcome the force of gravity. When the services of soil biota are mobilized, this adds the equivalent of 'jet propulsion' to rice production.

When we arrived in Haveri about noon, a driver from the Green Foundation met us at the station and took us to a local hotel where we left our things before driving 45 minutes to the village of **Chinnikatti**. Farmers here cultivate *ragi* (finger millet) in a very innovative – and productive – way. This coarse grain is the staple food for millions of Indian households, especially poor ones. It is grown as a rainfed crop, enhanced with supplementary irrigation where possible. Yields are usually in the range of 5-10 quintals per acre (1.25-2.5 tons/ha). A yield of 15 quintals is considered a very good yield (3.75 tons/ha).

The cultivation system practiced here in Chinnikatti, called *guli ragi*, has many resemblances to SRI for rice. It achieves yields of 18-20 quintals per acre (4.5-5 t/ha) and as much as 25 quintals per acre (6.25 t/ha) without use of chemical fertilizers. Also, 20 to 25 cartloads of *ragi* fodder are also produced per hectare which is valuable for animal production. After the Green Foundation learned of this system ten years ago, it began trying to promote *guli ragi* elsewhere. On the poster that it produced to describe *guli ragi*, the similarities with SRI are noted.

Farmers clear their field as usual for crop production, and then they create a grid similar to that with SRI. Furrows 18 inches (45 cm) apart are incised on the soil using a simple ox-drawn plow, pulled across the field in perpendicular directions. Then young seedlings, 20-25 days old (never more than 30 days old), are planted, 2 each at each intersection. Note that the word *guli* means intersection or node, so *guli ragi* is 'intersection millet,' implying widely-spaced millet.

The most innovative part of *guli ragi* is what is done to the growing crop. While the young plants are still supple, between 15 and 45 days after transplanting, when their stems will not break when bent over, farmers draw a simple ox-drawn implement -- a wooden implement called a *koradu* -- across the field in different directions. Bending the plants over traumatizes their stems at ground level, where root and shoot meet and where the plants' meristematic tissue which produces new tillers and roots is located. Dragging a *koradu* across the field 3 and 6 times during this period of early plant growth (during the third to sixth week) stimulates profuse growth of adventitious roots and also much more tillering above-ground.

The *koradu* is essentially a hollowed-out log, about 6-7 feet long and 15-18 inches wide, attached by ropes to the yoke of a team of oxen. A farmer stands on the *koradu* to add weight to it as he guides the team and the *koradu* over the field. Farmers showed me with pleasure the system of sticks and ropes that enables them to steer the oxen while riding on the *koradu*.

When other growing conditions are favorable, a single *guli ragi* plant will have 25-30 tillers, with heads that are considered 'fisty,' meaning tight and full. The larger root system enables the

panicles to be larger and better filled with grains. In SRI, we treat the young seedlings with the utmost gentleness and care; however, young *guli ragi* plants are ‘abused’ to achieve the same result -- larger root systems and more productive canopies.

The first thing we did in the village itself was to visit the village seed bank that AME has helped establish, with a huge variety of different seeds from dozens of local varieties of different crops. The somewhat elderly woman who serves as manager of the seedbank proudly showed us the biodiversity being husbanded and was pleased to have pictures taken of the facility.

The village temple, where we held our discussions, had a large covered veranda fairly freshly decorated with colorful paintings of deities. I was told that this is the usual place for meetings in the village. To begin the meeting, one farmer stood and sang a prayer, a song in praise of ragi, Krishna told me. The panchayat leader then greeted us, and we talked about *guli ragi* so that I could understand better its details. The farmers commented that at first the seedlings look “very sparse,” just as is said of SRI rice transplants. But they fill dramatically in the field once their growth accelerates.

There was no agreement on how old the system is. Some thought it was developed 25-30 years ago, but others said it was much older. The traditional method of ragi cultivation, still used in most villages, is to sow ragi seeds with the first rains. An improvement upon this is to broadcast seeds together with farmyard manure (FYM).

The introduction of sowing in lines to permit intercultivation (weeding) between rows was an innovation that probably came with colonial agricultural extension. However, it was not clear when transplanting in a square pattern was started, rather than rows, permitting intercultivation in perpendicular directions. Transplanting of ragi was prompted by good experience with putting young ragi seedlings in between rows of maize or cotton. *Guli ragi* requires more input of labor, they acknowledged, but the returns are several times higher than with conventional cultivation.

During our discussion, I suggested to the farmers that they experiment with transplanting of younger seedlings. Researchers at the Andhra Pradesh agricultural university (ANGRAU) have shown that, at 60 days of age, the roots of ragi plants that were transplanted as 10- or 15-day-old seedlings become much larger than those of seedlings transplanted when 21 days old. The picture that I showed farmers on my laptop screen was quite convincing, and many expressed willingness to try using very young seedlings.

We were invited to have lunch in a farmers’ home before going to see *guli ragi* in the field. How such a delicious meal could emerge from such a dark and smoky kitchen was a mystery to me, but the *jowar* (sorghum) chapatis were crisp and delicious. There were several forms of ragi served, including a sweet porridge that was eaten between the chapati course and the rice course. Most Westerners would have considered it a fine dessert.

We drove to some fields outside the village and then walked past a conventionally-managed field of ragi with a hybrid variety recommended for the area. The advantages of *guli ragi* using a traditional variety were immediately evident. There was no lodging in the latter, whereas there was much lodging of the fertilized hybrid field. Also the *guli ragi* grains were ripening

synchronously, something seen also with SRI, whereas the conventional ragi was maturing unevenly. The farmers said that stem borer problems are less when they use the *koradu*, and so are aphids.

The crop had not filled the field as much as I expected, so I asked whether they it might not be a good idea to try somewhat narrower spacing. Farmers said that what I was seeing was an effect of this year's drought. Normally the field would be well covered by now, they said, with a closed canopy. This year, they had been only able to do one *koradu* pass over the field during the first 45 days, so this was not a good example of the method.

I asked again, to be sure, when and where *guli ragi* cultivation had started, and they said it started here in **Chinnikatti**, and had spread over most of three neighboring taluks (subdistricts). We visited some other fields nearer to the village, and in one area, seven different ragi varieties were being grown. One (*Salemsana*) was particularly beautiful, bolt upright with brownish colored grains. This was direct seeded and has very good cooking qualities, farmers said. I told them that in the U.S., I eat millet 5-6 times a week, in the breakfast cereal that my wife prepares. Millet is increasingly appreciated as a health food in America.

Back at the temple, we resumed the discussion. They demonstrated another implement, the *yedekunte*, which is used for intercultivation. I had though this meant just weeding, but it clearly includes what I call *active soil aeration*. The long handle of the *yedekunte* is connected by a rope to an ox-yoke, and it is steered by a farmer walking behind. The implement being demonstrated was about 4 inches (10 cm) wide, with a blade of this width that digs about 3 inches (7.5 cm) underground. It is similar in some ways to what gardeners call a 'stirrup hoe.' It cuts off the roots of any plants (weeds) at that depth and also turns up this depth of soil, aerating it in the process. The implement can be made wider and able to plow more deeply. That this prunes some of the roots of the ragi plants growing in rows on either side is not considered a problem. One farmer said, 'My father always told me: if you break one root, you get ten more.'

For *guli ragi* cultivation, the *yedekunte* is pulled through the field between plant rows 5 or 6 times during the growing season -- "as much as possible," someone said -- starting from 15 days after transplanting. One of the reasons for *guli ragi* success, I am sure, is the active soil aeration it achieves, especially when used in perpendicular directions with square-planted seedlings. I congratulated the farmers on having such a 'modern' implement since active soil aeration is now being better understood through scientific studies to know how and why it contributes to better crop performance.

As the sun began setting, we said farewell and drove back into Haveli, where we had a leisurely supper at the hotel and got to the railway station by 11 for a scheduled 11:30 departure, taking the overnight sleeper train. Unfortunately, it did not come until 1:15, so we got back to Bangalore only at 8:30, not much before the SRI forum scheduled for 10:30 Tuesday morning.

### **SRI Forum at the Institution of Agricultural Technologists**

At the initiative of Dr. Dwarakinath, this rather unique institution had convened a forum on SRI. Two farmers giving leadership for SRI -- Narayan Reddy from Kolimirallapalli, and Krishna Rao from Raichur District, who had come also to the ANGRAU forum ten days before -- were there,

plus officials, researchers, journalists and others, well over 100 participants in all. **Vanaja Ramprasad**, executive director of The Green Foundation, was there, as was the AME executive director, Arun Balamatti, both co-sponsoring the event. The state Commissioner of Agriculture, **E. Ventakathiah**, presided over the session.

The Institute (IAT) was set up in 1979 and now has over 3,000 members from many disciplines, working in a variety of institutions, providing a forum for communication and cooperation across the whole agricultural sector. It has lectures or forums several times a month, sometimes several times a week, as well as a library intended to advance the knowledge and practice of agriculture.

When Arun introduced me as “the father of SRI,” I interrupted him to clarify that “The real father of SRI was a real father” (Henri de Laulanie, SJ); my role is that of communicator and proponent, not that of originator. Appropriately, the forum began with farmer reports.

**Krishna Rao** discussed how he started with SRI in 2003 on just one-third of an acre, using a Pioneer hybrid variety. By 2005, he was up to 80 acres of SRI. His seed rate has been reduced from 25-30 kg/acre to 1.5-2.2 kg (from 70 kg/ha to about 5 kg). He had some irrigation problems at first, but this crop survived for even one month without water. Farmers have faced difficulties getting rotary weeders, but he has continued to expand his area. He still uses some chemical fertilizer, but has greatly reduced its application. He is fully convinced of the applicability of these principles to improve paddy cultivation. He has talked with the Chief Minister about reducing the size of bags for seed paddy; 30 kg bags are not necessary and encourage overuse. Now that high-cost hybrid seeds are on the market, this suggestion is being followed.

Krishna Rao added: “Further, if SRI can be widely accepted, we can stop people fighting within command areas.” Nine crore acres of land are under paddy in Karnataka, he said. “If even 50% of this is put under SRI, we can solve the poverty problem.” He suggested that “Popularization of SRI can lead to another Green Revolution.” Just by its reducing the seed rate, SRI can save us 4,500 crores of rupees. “There is no doubt that SRI will become popular in Karnataka. We just need to make local adaptations.” His closing words were: “Promote, but do not impose” -- good advice to government agencies and NGOs alike. “Give farmers options,” he advised.

**Namjundarswamy** from Mysore district spoke next. He said that two Agricultural Officers informed him about SRI and gave him 5 kg of seed to try it with. He said that he was really worried, but they guided him through the transplanting. “They stood by my side.” Villagers were criticizing him, he said, even laughing at him. “But after 15-20 days, people started visiting my field and taking an interest.” The rotary weeder he was given reduced his costs of weeding. His plants had 45-47 tillers, and his yield was 4 tons per acre (10 t/ha). Before his yield had been 2.5 t/acre (6.25 t/ha). “It was difficult to harvest the SRI rice, there were so many panicles.” He said that a main lesson he had learned was that moisture is needed to grow rice, “there was no need to impound water.” Except for difficulties during transplanting while learning the new techniques, there were no problems. He is encouraging many other farmers to try SRI, he said in conclusion.

**K. P. Shivaram** from Keregodu village in Mandya Taluk spoke next. He said that when he first tried SRI, his father had challenged him, saying that if the crop did not survive, he would kick Shivaram out of his home for his foolishness. But the crop did more than survive, producing 60

productive tillers per plant. While labor and weeds can be a problem to manage, the results are worth the effort, Shivaram said in conclusion.

**B. K. Shankaraiah**, an agricultural officer in Mandya Taluk who had worked with Shivaram followed, leading off the presentations by technical personnel. There is now one farmer in his area who is practicing SRI on 12 acres, showing it can be done on a larger area. He himself was encouraged to begin work on SRI by his director. Despite his initial reservations, the crop did well. He has faced some problems, though, and one farmer with whom he worked did have a crop failure. Apparently the reason was in his rough uprooting of the seedlings. The officer at first thought that the nursery soil needed more compost to mitigate this problem; but in a comparison trial he found there was no difference. Farmers need to take care in their handling of the seedlings; indeed, “Farmers must take a personal interest in SRI for it to succeed. They must not just leave it to their laborers, acting like a large landlord.” A very perceptive observation.

Shankaraiah noted in conclusion: “Farmers believe that there is a special variety used with SRI, but this is not true. It is a matter of management.” At first, for his trials he had to pay the laborers an extra 3 rupees because they were afraid that it would involve more work. Also, there were some practical problems encountered such as getting seeds on time for timely planting. But this was not a fault with the method itself. He expressed confidence that this method would spread.

Next to speak was **P. G. Ramachandra Rao**, with the Agricultural Department in Piriyaipattana Taluk, Mysore District. He has been promoting SRI in two taluks, he said. The Department’s target for him was 5 ha, but he also did several additional hectares on his own. The two main problems he has encountered are seed dropping and stem borer. Also, when heavy rains came, small seedlings got flooded away. Weeders did not come to him on time, and he needed two per hectare, not one. The markers provided are cheap ones, not having proper bearings, so they are difficult to operate.

A problem Rao had seen is that when farmers doing SRI require personal attention, Department staff are having to spend their time in seed distribution, so they are not able to give their SRI work the attention that it needs. Farmers who use SRI methods have been seeing 35 to 78 tillers per plant on their crops. He thought that there should be at least 20 days between plowing for land preparation and transplanting; but with SRI, the time is only 3-5 days. Also, if you don’t put compost into the nursery soil, it is difficult to extract the young seedling without losing the seed sac attached to the root. Rao did not offer any summary assessment having enumerated a variety of difficulties encountered.

**Veera Brahmachari** from the Department of Agriculture in Kollar District said that in his area, they are introducing ‘semi-irrigated paddy’ (SIP), a variant of SRI. By using rotary weeders, weed management is easier with the new practices. Farmers are doing seed soaking for 24 hours to improve germination. Sowing pregerminated seed requires only 15 laborers/ha compared with 20-25 laborers for transplanting. They are seeing profuse tillering with the new methods, and farmers like this. SRI adopters are getting 5-6 tons/acre (12.5-15 t/ha). Weeding in both directions is very good, he said. Plant spacing is 30 cm. In his area, SRI use has gone from 20 acres to 150 acres in just one year.

Next Arun gave a presentation on behalf of AME, and then Krishna Prasad spoke for the Green Foundation, talking also about *guli ragi* system. As Krishna spoke, the Commissioner asked me whether any farmers in the U.S. are using SRI methods, and I told him, not yet. Rice-growing in America is highly mechanized and large-scale, so the growers in the U.S. have not realized any advantage yet from SRI methods, thinking they apply only for small-scale producers.

**Dr. Prabhakar Setty**, director of research at the University of Agricultural Sciences, Bangalore (UASB), began by paying tribute to the innovative work of Narayan Reddy, saying that ‘Sometimes scientists cannot take off their scientists’ hats,’ meaning that they do not take seriously any innovations that originate from the farming community. He advised working more closely together with farmers. His area of research is aerobic rice, developing and managing varieties that need less water. His view was that SRI will work best in areas where there is no shortage of water, i.e., where a regular supply can be assured, and that aerobic rice should be promoted in areas dependent on rainfall. Aerobic rice is now planted on 250 ha in Karnataka (certainly much less than the area under SRI).

Dr. Setty commented on the advantages that direct seeding offers to farmers in terms of saving labor and water -- with no nursery and no puddling. He equated SRI just with transplanting, a misperception that I corrected in my subsequent presentation. He also favored using two plants per hill instead of one, to have more assurance of survival. He said that SRI is giving a 30% yield advantage, while aerobic rice offers a 40-50% gain. (He did not comment on differences in profitability which would favor SRI because it reduces rather than increases costs.) He did say that we should be finding more eco-friendly ways to control weeds than the use of herbicides. Also he said that appropriate cropping systems and crop rotations need to be developed, rather than always planting only rice.

**Dr. Maidu Nair** from the Soil Survey Laboratory of the Indian Council for Agricultural Research, based in Bangalore, spoke next. (After working on SRI in the state of Kerala for three years, he had contacted me by email shortly before this trip to India to tell me about his achievements.) He explained how in 2004, he happened to be working on a project in Kerala to find out what are the main soil-related constraints to rice production in Palakkad District. Yields there had been stagnant for three decades, despite all of the efforts to introduce Green Revolution technologies, HYVs and high chemical inputs. Farmers there were no longer wanting to cultivate rice because it is no longer profitable.

Quite by chance he learned about SRI from a student seminar, and he became interested in it from a soil chemistry viewpoint. He had always been taught that rice grows best in waterlogged soil. That this might not be correct excited him, and within a month’s time he had gone through most of the literature available on SRI, particularly from the Cornell web page for SRI.

Initially SRI was tried out on two farmers’ plots, just 400 m<sup>2</sup> each, in the 2004 rabi season, making comparisons with equal areas under conventional practices, flooded soil, and closely-spaced older seedlings. These practices gave a 3.3 t/ha yield, while the SRI plots gave 6.5 t/ha.

In 2005 kharif, one of the farmers expanded his SRI area to 1 acre, with 5 different varieties. His yields that season were 5.5 to 8 t/ha, while his fields with HYVs gave an average yield of 3 t/ha.

In addition, 27 other farmers in the village tried out SRI on their fields, and they had yields of 6 to 7 t/ha. One got a yield as high as 10 t/ha, quite remarkable in Kerala.

Now in 2006, use of SRI has spread to many parts of the district, on various kinds of soil, while yields continued to be roughly doubled, even on very acid soils with high rainfall. There has been some objection that under such conditions, one cannot have aerobic soil. “But if you let the water flow out of the field, good results are possible, as the rainfall contains dissolved oxygen. Flooding for 3-4 days is okay with SRI.”

Nair showed pictures of the way that seedlings are grown on a plastic sheet and then put on trays at 9 days to be transported to the field. He showed the way that channels are cut in individual plots to drain water. His pictures showed profuse earthworm casts on the soil surface, giving evidence that biological activity in the soil is very great despite its intermittent saturation.

“For one month, you will have a miserable feeling,” Nair warned, “because initially the tiny transplanted seedlings look quite inadequate to the task of filling the plot. But with weeding every 10 days to aerate the soil, they will respond.” He said farmers working with him have gotten up to 80 tillers per plant, with huge root systems. This root growth he identified as “the single most important reason for SRI production,” showing pictures of large SRI root balls.

Nair analyzed the economic results of SRI practices, comparing plots where yields had been 6,316 kg/ha with SRI and 3,512 kg/ha with conventional practice. The net returns per hectare were 24,651 rupees vs. 7,412 rupees, respectively, more than a three-fold difference. Also, he reported that there are very few pests and diseases with SRI rice, and “recovery is rapid if the crop is affected.” Farmers also observe that the plants are resistant to lodging from rain.

Even with incomplete or imperfect transfer of this methodology, he said it giving good results. The two difficulties encountered are: (1) many farmers find it difficult to plant in line; they are reluctant the first time, although the next time, there is no objection; and (2) weeding is still too laborious for many farmers; there is need to design motorized weeders.

In my presentation, I stressed that SRI is still “a work in progress,” being developed through every successive season and in many different countries. I also suggested that SRI is better used as an *adjective*, describing an alternative approach and different principles of rice production, than as a *noun*, referring to a set and specific thing. I talked about the need for ‘post-modern agriculture’ in this new century, because conditions are different from those under which 20<sup>th</sup> century ‘modern agriculture’ was developed and will in all likelihood continue to diverge.

Land and water resources per capita are declining, so extensive production strategies with high energy costs will become less and less economic. Energy and other input costs are likely to be much higher in the 21<sup>st</sup> century, so factor proportions will need to change. We will also need to be more mindful of environmental impacts of agriculture, trying to improve rather than degrade soil and water quality and to conserve biodiversity. Climate change is likely to make present practices more precarious, so that we need to stimulate greater root growth, as results from SRI practices, to make our crops more ‘drought-proof.’

I suggested that since SRI paddy rice has a higher outturn of milled rice, by about 15%, it would be fair for farmers to get a 10% premium paid for their SRI paddy; otherwise, only millers reap the benefit of this productivity windfall. This would be a way of giving farmers an incentive to adopt SRI (and save water) that does not require any subsidies from government. I went further to suggest that agricultural laborers should be trained by NGOs or government programs in SRI methods, particularly in transplanting and weeding, so they could receive certificates that testify to their skill in these activities. As trained SRI laborers, they should get a higher wage, perhaps 25-30% more per day, in recognition of their greater skill which contributes to higher yields and profits for landowners. This would be a way to share with laborers the great windfall of SRI productivity. This suggestion was not applauded, but maybe socially-conscious persons in Karnataka and elsewhere will think about it and pursue it.

In a period for questions, various issues were raised. The most interesting was on asynchronous ripening. With so many tillers, SRI plants are expected to have panicles at different stages of maturity when harvest time comes. One person in the audience raised this as an issue. I responded that because colleagues at Cornell have raised this same question, I have asked dozens of SRI farmers about this. So far all have reported that with SRI methods they have synchronous ripening, even on very large plants.

Dr. Nair commented that in his experience, this was generally true, but that he had found one variety (from Tamil Nadu) which did not have synchronous ripening with SRI methods. All the others did. Narayan Reddy added that he is in his sixth year of SRI production and has had plants with as many as 94 tillers. There is generally uniform ripening, except that he has found that tillers produced after the 65<sup>th</sup> day are infertile. All others ripen within a 4-day range.

Another good question concerned water management and whether alternate wetting and drying (AWD) is suitable on heavy clay soils. I said that our initial advice was based on Madagascar experience, where drying the soils for several short periods during the vegetative growth phase has beneficial effects on rice plants' growth and yield. But we have learned from Nepal and elsewhere that some clay soils are not suitable for drying with SRI practice. They become too hard for roots to penetrate, even when rewetted. So water management practices have to be adjusted to soil conditions.

To conclude the forum, already an hour over schedule, the Commissioner thanked everybody and especially me for coming. He said that water saving and seed saving, plus increased income for farmers, are very welcome things for rice production in Karnataka. The saving of water is very evident with SRI, and this is a big issue in the state. He expressed his support for continuing efforts to popularize SRI in Karnataka. Afterwards, Shivaram, the third farmer who spoke, came up with nice pictures of his SRI field and results, which he gave to me to bring back to Cornell.

During the lunch that followed, a newspaper reporter interviewed me, and then I spoke some more with Narayan Reddy and R. Dwarakinath, who had joined the forum a little late. They have been friends for many years, Narayan Reddy pointing out that Dwarakinath has now met and been photographed with four generations of the Reddy family. I went back to the hotel, where Madhu Nair joined me for further discussion of his experience with SRI in Kerala. In his e-mail to me at Cornell, Nair had noted that his SRI work had been done in a personal capacity, out of

interest and curiosity, not as part of his official duties. All trials were conducted on farmers' fields, with no financial or other incentives provided.

Farmers have become convinced that SRI can increase their productivity and profitability, he wrote. However "The agricultural establishment is up in arms against me. Seeing is not believing for them." He is an advisor on rice development to the Kerala State government for its 11<sup>th</sup> State Plan, he said. From his experience in Palakkad District, he can say that simply using young seedlings, planted singly, 25x25 cm, with quick and careful transplanting and aerobic soils, it is not difficult to get 6 tons/ha, which is about double the current average yield in Kerala. This is without making any change in weed control methods or fertilization, so the benefits of soil aeration and organic matter are not included in this 'minimum SRI.' With more complete use of the system, he said 10 tons/ha or more are attainable, confirming our experience elsewhere.

Recently, Nair has been able to get a 1.5 million rupee grant from UNDP-GEF in India made to a NGO with which he works to do SRI dissemination. He was happy with what has been done so far with minimal resources and looks forward to scaling SRI up to the whole state. I was particularly pleased to have such a well-trained agricultural scientist who specializes in soil dynamics now taking an active interest in SRI. He can help us gain a better understanding of how SRI methods change soil chemistry, not just assuming that flooded soils are best for rice growth.

In the evening, I first visited Dwarakinath's home for tea and gift-giving, including a ceremonial sandalwood garlanding from student to teacher, a precious experience for both of us. Then I went to the home of Vanaja Ramprasad for dinner with her and her husband and several AME staff. So much hospitality and so many interesting discussions on how agricultural practice and strategy in the state are changing, or have to change, under contemporary conditions, especially if the basic human needs of the large majority of smallholding, resource-limited farmers are to be served. More time in Karnataka would have been useful, but the four days had been well-spent. I next traveled onward to visit SRI colleagues in Pakistan, which is a separate trip report [URL].