

REPORT ON SRI FIELD VISITS IN TAMIL NADU AND ANDHRA PRADESH, INDIA

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SUMMARY

Based on 10 days in Tamil Nadu and Andhra Pradesh states, with most of the time spent in field visits but also some time in their capitals, Chennai and Hyderabad, the following observations and conclusions are put forward, elaborated and backed up in the trip report that follows:

1. Top-Level Support: SRI is gaining official acceptance in both states quite rapidly, due to the documented and dramatic improvements in yield and productivity with SRI methods, with water saving and reductions in the cost of production, but probably most directly due to the expressed satisfaction of farmers who have used these methods on their own fields. The AP Minister of Agriculture endorsed SRI publicly before a large gathering of farmers while I was in that state and sent a request to the World Bank to include SRI support in its poverty reduction project in AP, and the Secretaries of Agriculture in both states stated their support for SRI. The agricultural universities in both states, TNAU and ANGRAU, are working with SRI, both to evaluate it and to disseminate it through their extension systems.

2. Farmer Satisfaction: Farmer approval of SRI is vocal and is leading to efforts to disseminate SRI farmer-to-farmer. Numerous non-farmer volunteers are also helping to spread knowledge of the methods and their results. With SRI, farmer economic returns are being even doubled, according to a TNAU analysis of farmer data. The profitability of rice production with SRI methods was calculated as 21,217 rupees/ha compared with 10,550 rupees/ha using conventional methods. Since this was achieved with SRI yields not yet attaining the higher levels that many farmers in both states have shown are possible when the methods are used well, there is scope for SRI to increase still further the profitability of rice production.

3. Farmer Innovations: Farmers are adapting SRI methods to different soil, climatic, pest and other conditions and are reducing the labor requirements of the methodology by devising better implements. SRI is thus evolving and becoming more diversified, which is desirable. Examples of labor-saving inventions are a weeder that removes weeds and aerates the soil in two rows at the same time instead of one, and a large, light 'wheel' for marking more quickly the spacing intervals for transplanting young seedlings.

4. Labor Requirements: Implements like those just mentioned are helping to save labor time, but more important is the effect of learning how to use SRI methods more skillfully and quickly. SRI is initially more labor-intensive, but requirements diminish over time. One group of laborers told me that the number of person-days required for transplanting has reduced from 30 to 10 as they become more experienced. With good planning, the start of SRI operations can be staggered in a way that reduces peak labor requirements and spreads the demand for work over a longer period, thereby creating more labor opportunities.

5. Labor Remuneration: An emerging issue is the rate of payment for agricultural laborers using SRI methods. There has been some reluctance of laborers to use SRI methods unless paid

more for the extra effort, but it appears that laborers are becoming aware that these methods increase productivity, and they want a share of this gain for themselves, not letting it all accrue to landowners. There could be conflict in the future if farmers will not pay more for hired labor to practice SRI -- not just (or so much) because more work is involved, but because of questions of equity if their returns are being doubled. One institutional innovation could be to train agricultural laborers and certify them as properly skilled and motivated to be more productive, justifying higher pay. One group of farmers with which this was discussed indicated willingness to pay a 25% premium for labor provided in a timely and skillful way.

6. Spread of SRI: Based on the experience with SRI in this season and on farmer satisfaction with the methods, the extension service in Tamil Nadu is preparing to push for 50% use of SRI methods next season in the Cauvery Delta, known as that state's 'rice bowl.' This will present information dissemination and training challenges, with possibly also a need to address the equity and compensation issues noted above. The director of extension in Andhra Pradesh expects there will be at least 10,000 acres will be under SRI next season based on the results obtained by 300 farmers in this first season since SRI was introduced in Andhra Pradesh. As many as 7,000-8,000 are using SRI this season. The plans for scaling up that farmers expressed during field visits indicated that very rapid spread is occurring. One farmer this season is already growing SRI rice on a contiguous extent of 110 acres, showing that SRI methods are not limited to small-scale cultivation.

7. Role of Women: Some of the most convinced and convincing SRI users are women, who could be dynamic proponents if given a role in the dissemination process, particularly communicating with other women. Training programs should include women and maybe emphasize their access to SRI. Also, since most of SRI transplanting is by women, we need to be sure there is no gender bias limiting their access to knowledge and opportunities.

8. Water Saving: One of the driving forces behind the acceptance of SRI, both by farmers and by policy-makers, is the potential for making major water savings. Water shortages in both states are becoming chronic as well as acute. SRI will probably be most readily accepted and implemented where farmers use groundwater for their water supply, because they have both the means and greater incentive to use water sparingly. Within canal irrigation systems, officials need to work with farmers to devise distribution plans that can enable farmers practicing SRI to keep their fields from being continuously saturated but also to be sure of having the small amounts needed when and as they are needed. Some combination of hardware and software modifications will be needed to get the full benefits of water saving that SRI offers. Also, to calibrate water savings possible with SRI, there need to be evaluations covering whole command areas with all farmers using SRI methods for a season. If necessary, government should guarantee them against any losses, a very safe bet.

9. Advantages with SRI: These continue to increase as farmers in Andhra Pradesh found that their SRI crop resisted lodging and shattering even under cyclone conditions while their neighbors' fields were devastated. Millers are finding grain quality enough improved with SRI methods that they are promoting it and willing to pay more for SRI rice, because it has fewer unfilled grains and fewer broken grains. Measurements have shown SRI rice to be heavier but not with larger grains, i.e., denser but not 'coarser.' This preserves its market value.

10. Agricultural Development: SRI represents a new approach to improving agricultural production, not relying on genetic changes in crop potential or on increasing inputs (fertilizer, agrochemicals, water). Instead, it works with any rice variety and reduces need for inputs, except for labor at first. SRI succeeds by capitalizing on potentials for greater root growth and for increasing the contributions of soil biota to plant nutrition and health. These organisms can be inhibited by ill-considered reversion to 'standard' agricultural practices developed as part of the Green Revolution.

Care should be taken that reflexive thinking favoring use of fertilizer or pesticides as a matter of course does not undercut SRI, e.g., prophylactic application of chemical pesticides on SRI nurseries. There can and will be some appropriate uses of both fertilizers and pesticides with SRI; but decisions on this should be approached carefully and empirically, giving biological approaches first chance.

Some rice varieties are genetically more responsive than are others to SRI practices, e.g., MTU 7029 or MTU 1071, so systematic evaluations should be done to enable farmers to get the most benefit from SRI methods by using them with the most productive varieties. Traditional varieties can perform much better with SRI, so all kinds of rice should be evaluated under different soil and climatic conditions. Most improved cultivars have been selected previously for what now appear to be sub-optimal growing conditions, close planting with continuously flooded soil.

11. Phenotypical Changes: One of the things that is building interest and enthusiasm for SRI is the obvious changes in phenotype that SRI practices induce in rice plants. Farmers are becoming very conscious of root growth, having largely ignored this in the past, as have most researchers. During my visit to Andhra Pradesh in September, N. Subba Rao in Achanta village, who was the first AP farmer to use IR-8 back in the 1960s, was displaying the large roots on his SRI plants and we agreed that SRI could be referred to as "The Root Revolution." Anyone who has capacity to receive large-file pictures and who would like to see the huge root system on a SRI plant taken at the Maruteru rice research station by Dr. P. V. Satyanarayana, just request this from me at ntu1@cornell.edu This plant came from a single seedling transplanted at 10 days into a field with wide spacing and aerated, composted soil. Both tillering and root growth are increased by the set of SRI practices used, leading to increases and improvements in grain yield.

TAMIL NADU STATE: Field visits started after lunch on January 22, after flying early that morning from Chennai (Madras) to Madurai. There I was met at the airport by Dr. B. J. Pandian, professor of agronomy at the Agricultural College and Research Institute in Killikulam of the Tamil Nadu Agricultural University (TNAU). It was a three-hour drive to Tirunelveli, the major town not too far from the Killikulam campus. Shortly after arriving at the hotel, Dr. T. M. Thiyagarajan (TMT for short), dean of the College, and other staff members joined us for lunch, a tasty South Indian *thalli* with a great variety of vegetarian foods. TMT was the first scientist in India to take a serious interest in SRI, and he has worked with it now for three years.

Based on his trials, confirming the yield and water-saving advantages of SRI methods, TMT was able to persuade the State Government to provide \$50,000 of its own funds to support further SRI trials and demonstrations in various areas of the state. TNAU has a role in the state similar to land-grant universities in the U.S., so it operates an extension service and has many interactions with farmers. Throughout my three days in Tamil Nadu, I was impressed by the easy and friendly interaction between TNAU staff and the farmers whom we met, whether they were white-shirted local panchayat leaders or Western-dressed progressive farmers or bare-chested, barefoot, often-turbaned *ryots*, the Tamil word for farmers.

January 22 Field Visits: We left on schedule at 12:30 and had a half-hour drive to **Tharuvai**, where Th. Arunachalam and several other farmers trying out SRI methods met us along the road. All of the SRI trials we saw had red and white signboards specifying the variety used, the date of planting, etc. TNAU staff are working with the farmers to maintain detailed records on each SRI plot and a comparable plot being cultivated with conventional methods.

Like most of the farmers we visited, Arunachalam is using 20x20 cm spacing for his SRI. This is somewhat closer than I would recommend, having found 25x 25 cm a better starting distance. However, even going to 20x20 cm spacing is a big change for farmers, according to TMT, so they are proceeding in steps. These SRI plants were started in the nursery December 5 and were transplanted December 20, so Arunachalam's crop was a little more than a month in the field.

Already he is seeing a big difference between his SRI and control plots. He commented that although planting young single seedlings in a precise square pattern requires more labor, weeding with SRI goes more quickly and is easier. Using a rotary hoe is less arduous than finding and removing weeds among more closely spaced plants.

All the farmers we visited are using SRI methods for the first time, so none could report on any prior season experience. I reminded people again and again that any real assessment of SRI must wait until the crop matures and has been harvested because rice plants can be surprising -- in either direction. They can disappoint as well as amaze.

Next we visited **Karukurchi**, about 20 minutes away, stopping to see the field of S. Paramisiyan. TMT told me that had raised his SRI seedlings literally "on his roof." The nursery are needed for a small field with SRI is very small, so it was easy for him to set up his seedbed there. His stand of rice had been only 14 days in the field; the plants were still small but already looked vigorous.

The drive to **South Pappankulam** took about 15 minutes, mostly off the main road. We came to a Catholic institution that has its own farm, and a number of local farmers who work with it. Several are working with organic farming methods, and one spoke very good English (he had visited Gettysburg, Pennsylvania). The SRI field we visited looked very good. The farmer had not been able to do a fourth weeding because the canopy had closed too much by then. We discussed this as one reason why 25x25 spacing is usually better, giving farmers a chance to aerate the soil one more time during the plant's vegetative growth phase. They were using a different rice variety, so the SRI plants were not taller than the conventionally-grown ones, 48 vs. 57 cm, but the number of tillers per hill (1 plant vs. 3) was 36 vs. 25. After visiting the fields, we were invited to sit a while in the institution's outdoor meeting hall and drink young coconut milk, very refreshing. Given the connection with a Catholic institution, there was interest in how SRI had been developed in Madagascar by a Jesuit priest, Fr. Henri de Laulanié.

It was about 20 minutes to **Ambasamudram**, where we met S. Perumal, who showed us his SRI field, which was doing well like the others. It was from there half an hour to **Vagaikulam**, where we saw the SRI plot of K. Subbaiah. He had transplanted his seedlings at 17 days, older than the others, because he couldn't get the labor on time. The plot was doing well, but there may be some eventual difference in performance because the transplanting was probably done after the start of the fourth phyllochron of rice plant growth, a critical time affecting tillering and root growth potential.

The village of **Alwarkurchi** was another 20 minutes away. E. Balasubramanian and P. Ganesan met with us there. Their SRI tillering has been very vigorous, 21 vs. 14 tiller per hill and 19 vs. 12 per hill, the SRI totals being for single plants while the lower figure is for clumps of plants. Farmers are seeing this phenotypic difference resulting from SRI practices very clearly. The height of their plants, as measured by TNAU staff, was also very different: 71.5 vs. 53.5 cm, and 64 vs. 49.5 cm.

The most interesting stop of the day was at **Thenpathu**, worth almost an hour's drive to get there. The SRI farmer here is 'a lady farmer,' Mrs. A. Manonmani. She had been described to me as the most dynamic and motivated of the SRI farmers in the area, and I quickly saw why. She led us to her field with confidence and spoke at length, firmly and enthusiastically, about her experience with SRI. She was also obviously someone well respected in the village. After the visit, she insisted that we take time for some tea in their small but neat village panchayat hall. She brought in a number of women, who sat on the floor around us, and an equal number of men assembled, while scores of children flocked around.

We started with questions and answers on SRI, but the session soon became a discussion of how to capitalize upon biological processes in agriculture generally. There was a lot of interest in the contributions made by soil organisms. I was impressed by the intense attention paid by the women, perhaps thanks to the example of Mrs. Manonmani who is obviously a motivator and a manager. We stayed in Thenpathu until sundown, when a beautiful sunset added its 'goodbye' to the dozens of hands waving to us as the TNAU bus pulled out of the village square.

The visits provided no conclusive results, since the plots ranged from 4 to 10 weeks in age. But all the farmers trying out SRI expressed satisfaction with what they are seeing in their fields.

They were particularly pleased to be able to save both seeds and water. Almost all of them commented that when they first planted their fields, however, their neighbors had responded with teasing and even derision. Once their plots reached a month in age, however, the attitude was now one of interest and usually appreciation. None expressed any reservations about having tried SRI, and most said they would plant their whole area with these methods next season.

January 23 Field Visits: Next morning with several TNAU colleagues we left Tirunelveli at 8 o'clock, heading toward the Killikulam campus with a schedule to meet various farmers along the way who are trying out SRI this season.

Once outside of the town we drove for half an hour through long stretches of barren land, with large rock outcroppings and little agriculture. These soils obviously lacked nutrients and water, but we discussed how they lack, more crucially, vigorous and diverse populations of soil organisms because of the long periods of dryness and the soil-heating effects of the sun. The microflora and fauna needed to access and provide the nutrients to support plant life have been largely lost. So these soils should be understood as biologically impoverished, due to climatic and associated physical and chemical constraints. Bringing them into a productive state will require a number of changes in soil conditions that can restore the life in these soils. Adding fertilizers can help in some instances, but in itself, it will not be sufficient.

After miles of barrenness, we came to large tracts of lower-lying irrigated land with very good soil conditions for growing rice. The visible change in vegetation should be understood as an indicator of different microbiological populations in the soil. The evident fertility is more than a matter of differences in water and climate or parent soil material. We agreed that the operative difference is biological.

The bus stopped near **Thirumalaikolundupuram**, where M. Murugaiah was waiting to meet us with other farmers by his SRI field, on what passes for a main road in the area. His farm laborer was there too and was a good source of information. The laborer said he was pleased with the methods he had been asked to use. The seedlings had been transplanted at 13 days, 20x20 cm, and weeding had been done 4 times.

Murugaiah was in the white shirt common for local landlords and political figures, and sure enough, it turned out that he is chairman of the local panchayat, and his wife is chairman of the union council, the level of local government above the village panchayat. He spoke of the 90% reduction in seed, and said that the weeding was easier, which the laborer agreed. It only took 5 days more for the transplanting, and this could be made up for by the time saved in weeding.

The laborer said that the transplanting was a little difficult at first, but it became easier, and he agreed that eventually, the methods will save labor in the transplanting operation because so many fewer plants are used. Murugaiah said that he wants to get all the farmers in the area to use SRI next season, as it will save seeds and water, and give better results. This is of course not something that should or can be done by decree. Tamil Nadu farmers have a long history of independence. He thought that the results which everyone could see -- many having at first disparaged the methods when the tiny transplants still looked scrawny -- would be persuasive. His endorsement as village chairman and a successful farmer will certainly help spread adoption.

Murugaiah pointed out to us the contrast between his field planted with SRI methods and the adjoining field, planted with the same variety, ASD 16, but conventional methods. The plants in the other were visibly shorter and less rich green in color. Normally farmers get about 5.5 t/ha in this area, with a maximum of 8 t/ha. so this is a good area for rice. The variety he had used, the most popular one in the area, is said to be 'shy tillering,' meaning its tillering is not profuse. But he was seeing about a 25% increase in tillers per hill with the wider spacing, one plant vs. many. He suggested, however, that he was thinking of trying 15x15 cm spacing next season instead, to have more plants per unit area.

We discussed this question at some length. I pointed out that the wider spacing is in large part what produces the more vigorous growth response he is seeing. When plants are closer to each other, less of the sun's light and energy can reach the lower leaves. These cannot produce as much energy for the plant, and the upper leaves in effect have to 'subsidize' the lower leaves. (This has been shown by our Indonesian colleague, Dr. Anischan Gani at AARD, who measured the illumination at different heights within the canopy when spacing is wider or closer.) All the leaves of more widely spaced plants get enough light to produce energy for the plant, and none of the leaves need to get energy from the others. Murugaiah said that he would try wider spacing, 25x25, on part of his field next season, along with some 15x15 spacing, to see what difference this can make. This question, like all pertaining to what are the best SRI practices, should be put to empirical tests.

Unfortunately, the TNAU bus which had transported us to effectively the way before would not start. For 45 minutes the driver tried various tricks, but it appeared we were going to be stranded for some time quite far from the TNAU campus, our goal by the end of the morning. Finally, a loose electrical connection was discovered and corrected, and we were on our way again, but behind schedule.

It was about half an hour to **Paraikulam** where S. Perumal met us, wearing a towel turban common with farmers. His average tiller per hill was 19 with SRI vs. 11 in the conventional plot. He showed us his weeding technique and expressed nothing but satisfaction with the SRI innovations. He remarked on the dark green color of the plants and said he had less pests. A few miles farther down the road, at **Vasavapuram**, we met A. Kandasamy, who has 17 tillers per hill with SRI methods and 10 with conventional. Tillering figures were given me by farmers and TNAU staff because there are not yet any harvest figures available, but all were anticipating proportionally increased production with the new methods.

Still farther down the road, still heading toward the Killikulam campus, the bus stopped and picked up 8 farmers waiting at a junction. We drove to **Padukaiyur**, where S Kasimani showed us his field, with 28 tillers compared to 14. He said his wife had been unhappy with his trying SRI at first but is now satisfied it is a good idea. (A year ago, a Cambodian farmer told a national SRI seminar at Prey Veng how his wife had left him when he tried SRI, because she thought he was risking the family's welfare, but once she saw the productive tillering, she came back.)

After stopping for tea in the local panchayat building, we drove back to the main road where one of the farmers traveling with us in the bus, K. Krishnan, known as a very progressive farmer,

proudly showed us his SRI field, which is right along the road at **Murappanadu**.. One of his plants, transplanted 8 weeks earlier at 14 days, already had 45 tillers, he told us. His average tillering improvement ratio was the best of the six farmers we visited that morning, 23 vs. 11. But the average for all six of the farmers we visited that morning was 20.6 for one SRI plant vs. 12.6 for clumps of multiple plants. Considering that SRI uses less water and much less seed, and resulting crops have better color and more pest resistance, this adds up to a lot of satisfaction.

We arrived at the TNAU campus at **Killikulam** about noon to see its on-station trials. They looked good, but not better than those on the farmers' plots. Of much interest to me was a set of replicated trials being managed by a student, Agnes, for her MS thesis, evaluating the effects of water-saving at different stages of plant growth. She is comparing normal water management (continuous flooding of 5 cm) with SRI management (2.5 cm added after the plot soil dries and begins cracking), for three periods: up to panicle initiation; from PI to flowering; and from flowering to maturity. Assessing flooding vs. not flooding during these three periods gives eight factorial combinations to be evaluated, with all other management according to SRI practices.

So far, the best growth is with flooding in all periods (T_1) and reduced water in all periods (T_5). Thus the most water-saving management is so far as good as the most water-using methods. Agnes is not measuring root differences for the different treatments, so we discussed how she can add this intervening variable to her research design. My hypothesis is that there is more root growth with the water-saving methods, and that this will have an effect on yield when the plots are harvested. Even if T_1 and T_5 have equal above-ground performance, there could be big below-ground differences that would contribute to differences in ultimate results. Unless root differences have been documented, however, we can still only speculate on or infer reasons for results. Most agronomic research still pays little or (usually) no attention to root systems.

We had an informal meeting with TNAU faculty in the Dean's office. The head of the Entomology department said that he is now interested in SRI and had observed that with young seedlings, there can be greater damage from whorl maggot to seedling roots. He was going to recommend that farmers apply preventive insecticides to their nurseries so that they can be sure of transplanting maggot-free seedlings. This led into a discussion of how chemical insecticides, by affecting the populations of soil flora and fauna, can themselves contribute to pest problems, something that IPM experience has shown. I cited a figure given me recently by a Cornell colleague: in the past 50 years in the U.S., the application of insecticides has increased 14 times, yet the percent of crops lost to pests has almost doubled, from 7 to 13%.

We don't know exactly what would have happened in the absence of such chemical use, but much of what is known now about the importance of beneficial organisms to keep pests and diseases in check suggests that widespread use of chemical controls, and especially prophylactic use, has contributed to the problem. The idea that SRI dissemination would be accompanied by widespread chemical dosing of rice nurseries was rather appalling. Most of the faculty supported my concern since many of them are working with biofertilizers, organic farming, etc., and understand well the issues I was talking about.

None of the farmers with whom I talked in the previous two days had indicated that this pest was a problem. Indeed, most commented spontaneously on how much freer their crops were of pest

damage when they switched over to SRI practices. It is possible that the whorl maggot could surface in the future as a constraint for using young seedlings with SRI, in which case, various biological control methods might be tried out first before resorting to chemical measures. SRI is not in principle 'organic'; it does not reject all use of agrochemicals. However, experience with SRI suggests caution in resorting to inorganic interventions since we know that soil biological processes are important for achieving SRI results.

After lunch back in Tirunelveli, I left with Prof. Pandian and Prof. Muthusankaranarayanan, head of the TNAU agronomy department at Killikulam, to drive to Tiruchy, a major city in the heart of the Cauvery delta agricultural area. We got in after 9, and went to the Southern Petroleum Industry Corporation guesthouse. I wondered how SPIC might like to have me staying there when the production system I am working with reduces the demand for petrochemical products.

At 9:30, an experienced SRI farmer, S. Gopal turned up at the guesthouse, having come from his home in **Kadiramangalam** 80 km away to meet me. We had met previously in September at an international conference in Killikulam,. There he explained to me an adaptation of SRI that he has devised, now called Kadiramangalam SRI, that involves double transplanting of young seedlings. They are transplanted from the nursery, first at 14 days into clumps of 5 plants, spaced 15x15 cm; then at 30 days, these are transplanted again into single-plant hills 30x30 cm. He said that this ensures their survival in the desiccating conditions of the Cauvery Delta. Based on his previous experience, he said he could assure farmers a yield of 7.5 t/ha with these methods, so that the additional labor required for a second transplanting was a well repaid.

Actually, his yield this season turned out to be 9 t/ha, making the method even more profitable. Gopal gave me copies of a letter from the Secretary of Agriculture, Dr. R. Kannan (at the time, Tamil Nadu Commissioner of Agriculture) commending the Kadiramangalam SRI method, and, of a certification of the 9 t/ha yield issued by the Assistant Director of Agriculture for his Thiruvidadimarupur district.

Of more interest to me were the pictures he brought to show me (giving me a CD-ROM with copies of the pictures to take back to Cornell, for our SRI web page). He has designed and build a 'bi-weeder,' an implement with two sets of rotating-hoe parts so that he can weed (and aerate the soil in) two rows at the same time, instead of just one. He said he has plans to build a four-row weeder that he is sure will work. It will need to have some adjustments for larger plants as the vegetative-growth period progresses, but he thinks this is feasible.

I told Gopal about the motorized weeder that a Sri Lankan farmer, Subasinghe Ariyaratne, has built for use on his 5-acre SRI field. Gopal asked for the SRI home page address so that he can see a picture of this on the internet. (He is progressive not just in farming but also in use of electronic technologies.) We will put a picture of his bi-weeder up on the SRI home page when I get back to Cornell.

January 24 Field Visits: This day started at 7 o'clock with a drive to the TNAU engineering college campus at **Kumalur** outside of Tiruchy. The college is monitoring six SRI trial-demonstration plots with farmers. On the drive, one of the faculty told me, with great confidence, that having more profuse tillering of rice plants is not necessarily desirable, because there is a

negative relation between number of panicles per plant and the size of the panicles. I agree with him that this is the standard view in the literature, but with SRI methods, we find just the opposite: *a positive relation*. SRI plants have both more panicles and also larger panicles.

Why? Because when rice plants are not kept continuously flooded, their roots do not atrophy, and the plant remains an 'open system,' acquiring nutrients throughout the growth cycle. It does not have to rely only on translocation of nutrients from the shoot and root to the grains, as happens when roots have degenerated, making the plant into a 'closed system,' where there must be tradeoffs between root, shoot and grains. This surprised him, but the evidence of large increases in yield supports this. When the methods are used well, we have seen doubling or tripling of yields, impossible if plant growth is limited by 'diminishing returns.'

After breakfast with some of the faculty, we visited first V. Shanmugam at **Sirumayangudi**, who was very pleased with his SRI crop so far. Its single plants average 40-50 tillers compared with 20-30 tillers on nearby conventional clumps of plants. When asked what was the biggest problem he faced with SRI, he said it was leveling the field so that a thin layer of water could be applied without drowning any of the young seedlings at first. He said he has improved his techniques as a result of experience.

He commented, as did many of the farmers we visited, on the initial reception that his innovation got from neighboring farmers: curiosity, skepticism, even criticism and scorn. But now that they can see the rapidly growing crop, many are coming to see it for themselves. He is particularly happy with the reduction in pest problems and with the higher rate of effective tillering.

Shanmugam said that he thinks the method will spread rapidly. The extension staff have been coming to inspect his field so they know well his results, he said. Then one of the TNAU faculty told me something quite staggering: *the extension service for the Cauvery Delta region has decided that it will try to achieve a 50% coverage of this large rice-growing area with SRI methods in the coming season*. The extension leadership is satisfied with the results of this season's trials, and there is much expression of farmer enthusiasm. With no evident reasons for caution or signs of resistance, it wants to make a big push for SRI dissemination. The coming dry season should be even more suitable for SRI than the current wet season, since farmers will have less problem with the flooding of young seedlings, and also, there will be more incentive to try to economize on the use of water.

I suggested that such an effort should not be a top-down push, and that as much as possible, farmers with experience in using SRI should be enlisted to help carry the information to new farmers, having high credibility because of their personal experience. My TNAU colleagues agree that this is desirable, though whether this approach will be operationalized, I cannot know. My hope, supported by experience in quite a few countries now, is that the methods are robust enough that anyone already knowing how to grow irrigated rice can get improved results if he or she comes reasonably close to the recommendations. Each of the component practices confers some benefit, so even incomplete use will still maintain credibility for the methodology.

Next, we visited the village of **Anbil**, where I were met by M. Natarajan, secretary of the Farmers' Club which is working with TNAU. He is also the secretary of a new Internet Club for

farmers that has been set up with IRRI assistance. This enables them to be in quick electronic communication with TNAU and the Tamil Nadu Rice Research Institute to get quick help with any problems they encounter. They have a camera so that they can transmit pictures of pest and disease problems to an entomologist or plant pathologist who can give them advice without having to visit the field. This system is a 'first' in Tamil Nadu.

We walked some distance to Natarajan's SRI plot, in the middle of many mature fields of rice. One of the farmers with us walked straightaway into the middle of it to pull up a plant, to show me how large the SRI roots are. They were indeed impressive. The SRI plants here have 40 tillers average compared with 15-20 tillers in conventional clumps.

Other members of the club had joined us as we walked, so I asked the group what they see as the biggest problem with wider adoption of SRI. They said, almost in unison, 'labor.' It is hard to get agricultural laborers to use the SRI methods as expected. "They complain a lot about how difficult the methods are and ask for more money."

I responded that if laborers are skillful in their work and help produce more rice for landowners, they should deserve a higher wage. I asked whether the farmers here would be willing to pay a higher wage, say 25% more, to agricultural laborers who have been trained in SRI methods and who have been certified as able and willing to use SRI techniques to best effect. All the farmers nodded vigorously. (Certification would provide a justification for not raising the wage for all laborers across the board, which I know is a concern of landowners.)

While we stood on the bund of the field talking, half a dozen women walking by stopped on an adjoining bund to watch us. They are the laborers who do rice planting, I was told, so I went over to talk with them, and started explaining why we ask transplinters not to plunge seedlings down vertically into the soil -- because this inverts the root tips upward. They smiled, and one said that they know this already. Another woman said, rubbing her thumb and forefinger together, "We want to get paid more money for this work." The implication was not that the work was so much more difficult that they need more pay but that they know it is more productive for landowners, and if they was going to get more yield from laborers' work, they want a share of this increment. This is not an unreasonable expectation, since their skill and effort are creating added value.

It appears that with some negotiation and maybe some institutional initiative and support, some meeting of minds should be possible on this point. Farmers were willing to pay more for skillful use of SRI methods; the women laborers were willing to use the methods if they are better compensated. What is needed is some means to get willing buyers and willing sellers together.

Since agricultural laborers in the Cauvery Delta are very well organized to defend their interests and rights, I can imagine that once they see the greater profits being made with SRI, there could be strikes and boycotts if labor wages do not increase commensurately. Institutional initiatives to train and certify laborers who are skilled and motivated to use SRI techniques could facilitate the process of adoption. Otherwise, laborer expectations and demands could become a blockage.

This was a very useful stop, but the extended discussions had put us behind schedule. We had to rush back to Tiruchy, because the visit to Kumulur was worked into my program at the last

minute. Colleagues in **Thanjavur**, at the TNAU's Soil and Water Management Institute and the Tamil Nadu Rice Research Institute there, an hour's drive away, had expected me to spend the whole day with them as they have a larger SRI program going, so they had been waiting since morning. Back at the guesthouse in Tiruchy, Prof. V. Ravi, an agronomist in Soil and Water Management Institute was waiting for me. He took me as quickly as possible to the institute, calling several times on his cell phone to assure people that we were finally on our way.

After a cup of tea in the office of the director of the Soil and Water Management Institute, Dr. T. Jayaraj, and after talking briefly with the director of the Tamil Nadu Rice Research Institute, Dr. B. Chandrasekharan, who had heard my first presentation on SRI in Tamil Nadu (at TNAU's main campus at Coimbatore May 2002), we crowded into two vehicles to start the field visits.

The first visit was to P. Selvaraj near **Kulamangalam**. He was engaged in harvesting a large part of his crop with the help of dozens of other persons. He greeted me in traditional style, with a big garland, a handwoven yellow shawl, and fragrant sandalwood paste to smear on my forehead. The thrashing machine had to be stopped before we walked from his house to his SRI plot so that the chaff would not engulf us. His SRI plants, starting their flowering, had more empty spaces in the plot than I am used to seeing. Selvaraj attributed this to crabs, which had eaten some of the young seedlings, a problem that I had not encountered before with SRI. Next season, he said he will plant 2 seedlings per hill to deal with this problem, a sensible adjustment of SR methods.

Selvaraj expressed satisfaction with what he has seen from SRI methods, pointing particularly to the large difference in tillering, 41 vs. 18 on average. Since he had already set out chairs and a table for us, even though we were far behind schedule, we sat down to drink some young coconut milk and eat delicious bananas, grown organically with vermiculture technology provided by TNAU.

As we drove toward **Pudumathur** for our next field visit, I saw a beautiful green field in the distance and commented on the richness of its color. I was told that this was in fact the SRI field that we were about to visit. When we stopped by the field, M. Govindarasan met us with his laborer. The latter took over the conversation, expressing his satisfaction with SRI methods and results, saying that after a little practice, the methods were easier than the conventional ones. These plants were starting panicle initiation, and had 30 tillers, vs. 16 in the conventional plot, according to the TNAU data sheet given me.

Next, we drove to **Kallarpasupatikoil**, where Mrs. R. Kalivani came bicycling up as we stopped our vehicles. She was soon joined by three more members of the Women's Club that she heads. She had been described as a dynamic farmer, and was indeed one of the most impressive persons I met in the three days of field visits in Tamil Nadu. Clearly, any development efforts that leave out talents and leadership abilities like hers will be less successful than they could be. She had already taken up trichoderma production for biological control of pests, as well as other innovations suggested from the TNAU staff.

Mrs. Kalivani said that with SRI, she could reduce her labor for transplanting from 5 person-days to 3 person-days, so she was not finding SRI to present any particular labor constraints. Her plants were still in the tillering stage, with the average number of tillers being 20 for SRI

compared with 13 in the control plot. She and her fellow club members expressed strong support for SRI methods. Like Mrs. Manonmani whom I met on two days before, her energy and conviction could have a real impact on spreading SRI, especially among other women.

We had time to fit in one more field visit before the farmers' meeting scheduled for late afternoon at Edamelaiyur. This visit was to Th. Meganathan, a progressive farmer whom I had met at the international conference held at Killikulam in September. He is in his third season with SRI, having learned about it from TNAU staff after Dr. Thiyagarajan introduced the methods to a rice conference held at TNRRRI in 2002. He is not cultivating 3 acres of SRI rice, getting 2-2.5 t/ha more yield this way.

With us on these field visits was a former dean of the TNAU Agricultural College and Research Institute in Tiruchy, Dr. M. Sivanatham, now retired, whose brother lives in this area. The brother also learned about SRI at that time and started using these methods. Dr. Sivanatham said that he has been trying to promote SRI trials since he learned about the methods in 2002. He is an academic who has kept his 'roots in the soil' strong and continues to support agricultural improvements in his retirement.

Meganathan had done very well with SRI, adjusting spacing and timing to suit his conditions. He showed TNAU how banana leaves could be a cheaper and better material on which to put the SRI nursery soil than the plastic it was recommending. It was interesting to learn that he pays his laborers more than the prevailing wage in the area, thus having a labor force with more stability and loyalty. He has had no difficulty in getting them to use SRI methods. As we were leaving his field, Dr. Chelliah, a TNAU agronomist in our group, pulled up one of the SRI plants, with 58 tillers and a large root system, to take with us to the farmer meeting.

We arrived in **Edamelaiyur** about 4:30, with a large number of farmers already in the panchayat assembly hall. The panchayat chairman welcomed us. Within 15 minutes, the hall was full, and the program started with two teen-age girls singing the state anthem. First Dr. Chandrasekharam and Dr. Jayaraj spoke on behalf of TNRRRI and TNAU; then Dr. Ravi, Dr. Chelliah and Dr. Samiayyan from TNAU talked about SRI and also its relation to IPM, which has been promoted in the village. Then Dr. Sivanatham talked briefly. He referred to me as an "international scientist from IRRI," which I corrected thinking that the IRRI Director-General would probably be pretty unhappy with such a misidentification.

Finally I was introduced to give a keynote address. Having been described as "the father of SRI in India," I explained that "The real father of SRI was a real father." I recounted how SRI was developed by Fr. Henri de Laulanié, a Jesuit priest, who put together SRI by working closely with farmers over many years, observing and testing certain 'desirable deviant' practices that he found in use and then adding some of his own innovations, purposefully or by fortunate accident.

After reviewing the basic principles of SRI, I concluded what could have been a longer talk because it was getting late. I said that information on SRI is provided freely to everyone, with no licenses, patents, copyrights or royalties. (This elicited applause from the farmers when translated.) We hope it will benefit many people, especially poor ones, all around the world, and we hope also that it will benefit the environment. However, we make two requests to farmers:

(1) Don't just accept and use the information provided. Think about it and try to improve upon it. SRI is still new and being improved, particularly by farmers. (2) If SRI proves beneficial for you, please share this information and any innovations with others, so that they too can benefit from it. (This also met with evident farmer approval judging by the nodding of heads as it was translated.)

Because there were only two hours left to get back to the college and collect my suitcase and then to get to the train station in Tanjore, we had to make a quicker departure than would have been most appropriate. Farmers' interest and appreciation was symbolized by two beautiful momentos they they gave me. With Meganathan as an experienced and motivated SRI farmer, already making innovations, able to advise farmers here, and with the endorsement of Dr. Sivanantham, a respected and successful 'son of the village,' the methods should spread quickly here. The TNAU data sheet reported that in this village, with SRI methods the number of tillers per plant is already 42 compared with 12 per hill with conventional methods. This differential will surely reinforce local interest.

More important may be the economic analysis that I was handed during the field visit. From data collected from farmers, TNAU has calculated the costs of cultivation with SRI as 16,282 rupees/ha vs. 18,429 rupees/ha with conventional methods. This is a 12% reduction in costs which when coupled with increased average yield (6,500 kg/ha from SRI vs. 5,020 kg/ha usual), the net returns are doubled -- 21,217 rupees/ha from SRI vs. 10,550 rupees/ha with conventional methods. The cost of production for rice is one-third less with SRI: 250 rupees/quintal compared to 367 rupees/quintal with usual methods.

The average SRI yield obtained so far in Tamil Nadu is below what we have seen in other countries, 7-8 t/ha, so I would anticipate the economic benefits to improve still further. The profitability of SRI should increase still further as farmers learn the methods better and can reduce their labor costs and as their soil fertility improves as a result of the methods. But even with the initial level of achievement, SRI has a lot to offer farmers, not considering the water saving possibilities and the environmental and health benefits one can anticipate with it.

The return trip in the dark was rushed but uneventful. I was gotten to the Tanjore rail junction in time to catch the train to Chennai, and was sent off by a large TNAU/TNRRI contingent, with a packed supper of iddli and ootapam to be enjoyed with samba and other sauces. The train compartment was comfortable enough to get a decent night's sleep before arriving (an hour and a half early) at the central Chennai station at 4:30 am.

January 25: I expected to spend a quiet day in **Chennai** at the hostel of the M. S. Swaminathan Research Foundation (MSSRF), working on this report and other things. At 10 o'clock, Dr. K. Balasubramaniam, program director of the J.R.D. Tata Ecotechnology Centre next door to the hostel, called and said that he would like to talk about SRI if I had time. Of course. MSSRF has been doing its own evaluations of SRI since 2003. It has had good results, but wants to wait in releasing them publicly until it has confirmation from further trials. However, Bala is already working SRI into training programs. Just the previous day, he told me, there was a meeting at the Foundation with the Tamil Nadu government's Secretary of Agriculture, Dr. Kannan, to discuss agricultural strategy. All present endorsed the extension of SRI methods within the state.

Bala and I discussed how training programs could be organized for laborers to learn SRI methods so that they could be certified and made eligible for higher pay. MSSRF is already doing a variety of training programs for farmers and the landless, so the idea I had discussed with farmers in Ambul seemed feasible to him. We discussed farmer-to-farmer extension methods and other approaches to participatory technology development and dissemination. Bala is taking an active interest in the opportunities that SRI opens up and said that these are now widely recognized in Tamil Nadu. I left with him SRI training videos from Indonesia and Madagascar.

At this point, we were called to meet a group that Dr. M. S. Swaminathan was showing through the Foundation. (He and I hadn't known that we would be able to meet on this visit given the tightness of our respective travel schedules.) The group, which turned out to be from the World Bank, was headed by Kevin Cleaver, director of its Rural Development Office. Kevin and I had a chance for a brief conversation. Unfortunately, he had not been able to meet with the director of extension in Andhra Pradesh, about SRI while he was in Hyderabad as we had planned for. But he said that he had been hearing a lot about good things about SRI from various persons.

The positive words about SRI that M. S. Swaminathan said when introducing me to the Bank group were much appreciated. Over tea, a senior environmental specialist for the World Bank, N. R. Harshadeep, told me about several Bank projects in the South Asian region in which SRI is starting to be or can be integrated. So there appears to be growing institutional acceptance, even if no formal statements have been made.

January 26: This was a national holiday in India, Republic Day, so the morning flight to **Hyderabad** was not very full. I was met at the airport by Dr. Alapati Satyanarayana, director of extension for the Andhra Pradesh agricultural university (ANGRAU). On the way in to the ANGRAU guesthouse, which would be my 'base' for the next six days, he told me about several mechanical innovations by farmers to make SRI transplanting and weeding easier and quicker that we would see during the field visits.

After arriving at the guesthouse, M. Prabhakar Rao, managing director of Nuziveedu Seeds Ltd., one of the major seed companies in India, came by to talk about SRI and about agricultural development in general. SRI offers some real advantages for seed multiplication. Satyanarayana told me of one farmer who had gotten 2500 kg yield from just 1/2 kg of seed. Another seed executive, Narasimha Reddy, who is still heading up the Ganga-Cauvery Seeds Company at the age of 84, has already gotten about 2,000 acres under SRI methods, training farmers and providing weeders. Before Rao left, he said that his company is willing to pay for widespread distribution of farmer manuals on SRI and on soil health as a public service.

Before going to Satyanarayana's home on the ANGRAU campus for lunch, he gave me a sheaf of data sheets from all of the AP districts but Nellore, as well as pictures from the Maruteru rice research station showing SRI plants with massive root systems. Despite the evidence of SRI's effectiveness, the senior rice scientist at the station has still declined even to visit SRI plots. He also gave me an article (December 22, 2003) from a Telegu newspaper *Eeenadu*, a story with color photographs reporting that SRI crops had withstood the cyclone that had recently hit

Andhra Pradesh, with no lodging or shattering. That is some of the best publicity SRI can get since cyclone damage is a recurrent risk that farmers face here.

After lunch we met Prof. C. J. Stigter from Wageningen University at Satyanarayana's office. Stigter, founding president of the International Society for Agricultural Meteorology (INSAM), was interested to see the computerized data base on Andhra Pradesh agriculture that Satyanarayana has constructed to characterize the cropping systems in all 1106 mandals (sub-divisions) of the state. It is organized in such a way that the extension service can quickly respond to changes in weather forecasts before each planting season with recommendations on how the timing and mix of crops could be adjusted, given soil suitability, market demand, etc. It can also support quicker and more informed responses to factors like pest and disease outbreak during the season. Stigter and I were properly impressed by this capability that is now in place.

On the way back to the guesthouse, one of Satyanarayana's colleagues gave his feedback on the SRI trials this season. One of the most surprising was his comment that some of the farmers are now saying that they like doing the weeding with the cono-weeder and even do as many as 5 or 6 weedings because they can see the benefit this gives to the plant. (At the farmer fair I visited next day, I met a farmer who reported seeing 'real-time' improvements in crop status with weeding. He had been weeding in the morning and took a break for lunch. When he resumed in the afternoon, another farmer passing by stopped to ask him if he had put urea on the part of the field that he had been weeding in the morning -- because it looked greener than the rest of the plot. Normally, it takes a day or two for the effects of urea application to become visible. In this case, after a few hours, the crop was evidently more vigorous. Such information might be dismissed as 'anecdotal' by some scientists, but qualitative data can be 'significant' for various reasons.¹

January 27: Satyanarayana and I left Hyderabad on the 6:40 train in the morning and arrived in Guntur in the Krishna River Delta a little after noon. On the train, we happened to meet a doctor from Guntur whom Satyanarayana knew from having lived there for 20 years before taking up the post of Director of Extension at ANGRAU. The gastroenterologist, who already knew about SRI, told us that he is planning to plant 30 acres with the new methods next season. In this instance, the very randomness of the occurrence made it difficult to assess its significance. Still, it is worth noting as an indication of the spread of interest in SRI.

At the Guntur station, we were met by ANGRAU staff, including P. V. Satyanarayana, a young rice scientist at the Maruteru station whom I had met on my September visit. He was the person who took the picture of a SRI rice plant with a huge root system, set against the backdrop of rice research plots, that Satyanarayana had given me on Monday. We were taken to the guesthouse of the Best India Tobacco Suppliers company, owned by Sri Y. V. Rao, Member of Parliament for the area and friend of Satyanarayana's for many years, where we had a good lunch.

Afterwards, we proceeded to the Regional Agricultural Research Station at **Lam**, on the edge of

¹ In this instance, a random observer, a passerby, with some presumed some ability as a farmer to assess rice crop vigor, with no prior knowledge of the treatments involved (otherwise he would not have asked whether urea had been applied), considered the observed difference in crop color significant enough to stop and comment on it. Indeed, he attributed the difference to urea application even though he had the evidence of the first farmer doing weeding as a possible explanation.

Guntur, where a *kisan mela* (farmers' fair) was in progress. That noon, the station had served lunch to 3,500 farmers. This station was literally home to Satyanarayana since he worked there from 1980 to 2000, for the last five years serving as its director. When we entered the director's office, one farmer was already waiting for us, with a written-out list of 'doubts and observations' about SRI, according to Satyanarayana. The room quickly filled, mostly with farmers who knew him for many years. P.V. Satyanarayana said, as we waited to start, that there is now a lot of enthusiasm for SRI among farmers, "more than among scientists."

Among the farmers was B. Sudhakar Reddy, the first SRI farmer whom I visited in September, in the village of Akiveedu in West Godavari. He had planted 10 different varieties with SRI methods on 3.2 acres to assess different varietal suitability and is one of the most enthusiastic. The first farmer who had the 'doubts and observations' led off the discussion, asking why we did not recommend more application of nitrogen fertilizer. I could not follow all of Satyanarayana's response. He talked about one farmer who was impressed by the profuse tillering of his SRI plants and added a lot of urea at the flowering stage. This had the effect of inhibiting grain filling, leading to a disappointing result. Satyanarayana cautioned farmers against relying too much on inorganic fertilizer, instead managing soil, water and nutrients to promote biological N fixation in the root zone and in the roots themselves as much as possible.

To give some visualization to this appreciation of the importance of roots, I passed around a picture of a pair of rice plants that a Cuban colleague had sent, same age and same variety. The right-hand plant had been raised according to SRI principles, transplanted at 9 days and raised in soil with organic matter added. It had massive a root system, more than 10 times larger than the left-hand plant, which had been raised in a flooded nursery, with close spacing and fertilizer only, until removal for transplanting at 52 days of age, the usual age for transplanting in Cuba. Management practices could obviously make a huge difference in root development.

I added some comments on how soil bacteria can promote roots' growth directly by providing them with growth hormones, and Satyanarayana elaborated on this by telling the farmers about root exudation. He described how protozoa graze on the bacteria that grow on the roots and are fed by exudates, excreting nitrogen directly onto the roots because their own C:N ratio is lower than that of the bacteria they ingest. The farmers listened to all this very intently. He elaborated further on how biological N has more effective because it avoids nutrient imbalances and induced micronutrient deficiencies. The farmer who had raised the question that started this discussion said that his doubts were satisfied.

Next there was a discussion of labor requirements as a constraint on adoption of SRI. On the train ride, Satyanarayana had not been certain about the feasibility of the ideas for training and certification of laborers, with payment of a premium for their acquired skills, saying that people can learn these very quickly. His suggestion was that farmers stagger the planting of SRI rice so as to even out the demand for labor over time. Nurseries are small and require little seed. I had suggested that farmers could afford to make a succession of nurseries, being willing to not use some in order to have seedlings at the best age when labor was available.

Satyanarayana went over our ideas, suggesting that labor reduction with SRI was possible not by the third year, as I had suggested from data we had from Madagascar, but by the third day. A

farmer volunteered that in his case, where he had used 42 laborers the first day, by the third day, only 20 were necessary. Sudharkar Reddy who was in his second season with SRI said that he had transplanted his SRI fields this time with 15-16 laborers, compared with 18 before.

Remembering how one of the first things Reddy had done when I visited his fields in September was to pull up an SRI plant to show me how large its large root system was, I asked how many of the farmers had inspected the roots of their rice plants before they learned about SRI? None said that they had. One responded that before they hadn't paid any attention to their roots before. "Now we are all aware of the importance of good root growth." One farmer said that his SRI plants are still green when the panicles are mature, indicating very little senescence, something assumed previously to be an unavoidable biological process. Reddy said that he had gotten 8-10 t/ha yields on his 3+ acres, 9+ tons average dry weight, from all the varieties he tried.

One farmers asked how long the interval between weedings should be. I responded that this needs to be determined by each farmer for his own conditions, though we recommend starting with 10-12 day intervals from the time of transplanting, until the canopy closes. I suggested that they try some different intervals on different parts of their fields to see which is best for their soil, variety, etc. Different spacings and different numbers of weedings should also be evaluated empirically. "SRI farmers are managers, making evaluations and decisions, not laborers, just doing what they are told."

K. Rajpal from Kollalapudi village gave me a report on his and a neighbor's SRI trials, certified by the coordinator of ANGRAU's transfer of technology center at Ongole, with the following data:

Variety planted	Method	Date of nursery sowing	Date of transplanting	Plant height (cm)	No. of hills per m ²	No. of tillers per hill	No. of tillers per m ²
JGL 384	Farmer practice	16-8-03	15-9-03	85	40	7.2	296
	SRI	16-8-03	29-8-03	100	16	23.5	376
MTU 1071	Farmer practice	16-8-03	15-9-03	115	30	9.0	270
	SRI	16-8-03	29-8-03	120	16	25.0	397

His neighbor N. Ramakrishna in Dhenuvukonda village had planted NLR 27999 and MTU 1071 with similar results, except his numbers of tiller per m² were 343 vs. 506 and 368 vs. 502. Rajpal had harvest results written out by hand to supplement the official report by Dr. S. P. Moula:

Variety	SRI	Farmer practice	Increase in yield	% increase over farmer practice
JGL 384	8170 kg/ha	5780 kg/ha	2390 kg	41.3%
MTU 1071	7440 kg/ha	5700 kg/ha	1740 kg	30.5%

Dr. Moula's written observations from his visit November 13 were: "The incidence of leaf folder is observed in the plots but the severity is very low in SRI compared to farmers practice. The

tillers are very strong compared to farmers practice. In SRI plots at Kollalapudi, panicle initiation was observed (already) in JGL 384 and it was not seen in farmers practice." Rajpal said that Ramakrishna had gotten similar results from his SRI plots but he did not have the numbers.

Rajpal's cash costs of production had been about 6200 rupees/ha with usual practices, and 5800 rupees with SRI, a reduction of 400 rupees (about \$10) per hectare. Later I calculated the cash cost of production to be 1.08 rupees/kg with regular practice and 0.74 rupees/kg with SRI -- a reduction of more than 30%. No wonder he was pleased with the results. He said that his water use was also reduced, though he could not quantify this more than to say that he took water only once in three days, draining off any excess to keep the field unflooded.

Next, B. N. K. Kaundinya spoke up. He was identified as the farmer who had been asked whether, a few hours after weeding, he had applied urea to his crop. He said that his crop had withstood two cyclones, whereas all the neighboring fields had lodging, and their grain got submerged in the water, lowering its value. Sudhakar Reddy got a good laugh by commenting that normal hills of rice are like him (short), and SRI hills are like me (tall).

One farmer asked how to control certain insects that were cutting the roots of seedlings. Satyanarayana's suggestion was to use more organic matter in the soil, which would support larger populations of other organisms that could keep these insects in check. Someone asked whether SRI could be used with hybrid rice, and the answer was, yes, and there could be substantial cost savings because only about 10% as much of this more expensive seed would be needed.

I asked whether farmers have observed fewer unfilled grains in the panicles of SRI rice. One farmer said he had counted, and he had 4-5 unfilled grains with SRI, vs. 30-35 normally. This is one factor contributing to higher yield. I asked whether they see any other quality differences with SRI. Several said no, but Satyanarayana commented that in West Godavari, millers have offered 25 rupees per bag more for SRI rice because its outturn is higher. One farmer says that a good thing about SRI is that the grain weight is higher without the grains being larger (i.e., grains are more dense, which is good because consumers prefer fine-grained rice; larger grains are considered coarse and get a lower price per kilo).

This discussion went on for about two hours all together. At 3:30 we walked through the dozens of exhibits set up for the fair, by the extension service, by researchers, and by many companies selling implements, fertilizers, insecticides, etc. One was promoting neem products to protect against insect damage, and another had pheromone traps to reduce insect populations.

About 400 farmers were sitting on plastic chairs under a huge tent, listening to extension staff and researchers talk in turn about different crops and production problems, answering questions that farmers had. When we arrived in the tent, Satyanarayana as director of extension for the state was installed in the chairman's seat. Immediately after he sat down, some heated exchanges erupted, in which the only words I could make out in the Telegu were 'bt.'

Satyanarayana later explained that farmers were complaining that ANGRAU had not developed its own bt varieties for cotton and other crops so that they would have access to cheaper seed.

There was no controversy about the desirability or efficacy of this biotech innovation which enabled farmers to reduce greatly their pesticide applications. Last year, there had been a drought and there was no *heliotis* pest pressure on the cotton crop. Yields were low, and farmers who had invested in bt cotton were disappointed. But this year, with better rains, the situation is the reverse. Yields are better, but the pests are more, and those who planted bt varieties are getting better economic returns. So there is great demand for this technology.

At 5:15, the Minister for Social Welfare, Sri J. R. Pushpa Raju, arrived, along with Sri Y. V. Rao, the local MP, in whose guesthouse we were staying. The formal afternoon program began, with lighting of the oil lamp. When the MP finished his speech, farmers insisted on asking questions. Their gist was: why isn't the government doing more to ensure better marketing facilities for farmers and better prices? This is a familiar question all over the world, but with national elections coming up soon, it has partisan implications, as supporters of the opposition seek to discredit incumbents as part of the political process.

Because the Minister had to leave for another engagement, his talk was moved up on the agenda. When he finished, he was given the honor of 'releasing' a new extension leaflet on weed control, opening a nicely wrapped package and distributing the first 50 copies. I was given the similar honor of 'releasing' a new extension bulletin on SRI! I gave the first copy to Satyanarayana in recognition of his great efforts to bring SRI to farmers in the state of Andhra Pradesh. After these ceremonies, the dias was considerably depleted.

Mr. Padmanabha Rao, a progressive farmer who is a member of the ANGRAU managing board (and who before the program gave me a picture of himself and his family visiting Jimmy and Rosalyn Carter at their farm in Georgia) spoke next, at some length. By the time it was my turn to talk about SRI, the numbers of farmers had declined to about 100, but they were staying after 7 pm. Satyanarayana, who translated my presentation, said that the others had had to leave before this because they had long ways to travel home and had to go before public transport stopped. Those who remained were very attentive. We got back to the guesthouse about 8.

January 28: Next morning we left at 8:30. Traveling with us was a retired Assistant Director of Agriculture and 'SRI activist' who is also a homeopathic physician, Kotes Rao. Satyanarayana said that Rao is well known and widely appreciated for providing free medical services to those who cannot afford to pay. He is a follower of Sri Aurobindo and has gotten approval to plant 5 acres of SRI at the Auroville ashram in Pondicherry. Rao has been promoting SRI among farmers and wants to show himself what can be done. Auroville is the one place where SRI has failed to perform well. It has been tried for three years at Annapurna Farm, part of the Auroville community, without success. I visited the Farm in December 2002 and was puzzled why its SRI yields have remained lower than their regular rice yields, even though root growth was good. Possibly it is because of their heavy clay alkaline soils. I will be curious to find out whether Rao can do any better.

We arrived at the farm of Jaya Rao in **Churtalapudi** about 10. He was in the process of planting 10 acres to SRI, having gotten 8.4 t/ha yield the previous season where his previous rice yield on the farm was 3.5 t/ha. Young seedlings were being carried into the paddies on small tin plates, like pie pans in the US. Satyanarayana pointed out that they were letting the soil around the

seedlings dry out more than desirable. Also, they were planting too deep. On some of Rao's paddies the soil was first marked with parallel lines 25cm apart, and then cross-lines were drawn not perpendicularly but diagonally. This created parallelograms with spacing 25x25cm in one direction, but 25x50cm in the other, an interesting innovation. When harvest comes, we can see whether this kind of wider spacing is beneficial or not. As we left, Satyanarayana observed that while Rao is a fairly large farmer, he saw a small adjacent farm practicing SRI with family labor rather than hired labor.

We got to the Agricultural College at Bapatla about 11:45. A national seminar on Resource Management for Sustainable Development, organized for the Golden Jubilee (50th anniversary) of the *Andhra Agricultural Journal*, was already underway. The Minister of Agriculture, V. S. Rao, had already finished his inaugural address, and the former vice-chancellor of ANGRAU, Prof. I. V. Subba Rao, was giving his keynote address. Subba Rao made points that set the stage nicely for my talk, scheduled next. The Secretary of Agriculture, P. S. Sharma, had to leave for another engagement but said during the break that he would have lunch with Satyanarayana and me on Saturday when we were all back in Hyderabad. The Minister stayed to hear my presentation, on: "Why and How This Century's Agriculture Should Be Different from 20th Century Agriculture."

Following up Dr. Subba Rao's comments on the growing problems with Green Revolution technologies -- rising costs of production, growing water scarcity, adverse environmental impacts from fertilizer and agrichemicals, narrowing genetic base for agriculture, etc. -- I suggested that we need a 'post-modern agriculture.' This will be not the negative kind of post-modernism seen in the arts and humanities, but one that builds on existing scientific knowledge. It will proceed differently from 'modern' agriculture with its heavy dependence on energy and external inputs. Conveniently, SRI provides an example of agriculture that can be more productive with fewer inputs, that requires less water, that has beneficial rather than adverse environmental impacts, etc. This lower-input agriculture will not be a step backward but rather 'post-modern agriculture' will be the *most modern* agriculture, because it takes advantage of what is being learned in biology, soil ecology, natural hormonal growth regulation, and other fields.

Green Revolution agriculture relied on genetic changes and external inputs, whereas SRI depends on neither. It changes management practices for plants, soils, water and nutrients to promote larger root growth and soil biological activity in support of plant growth and health. We do not know how far such innovations can succeed with other crops, but in rice, farmers are getting definitely greater outputs by using less inputs by taking advantage of existing biological potentials. Genetic improvement has a place in such agriculture -- some varieties respond better than do others to these practices. But the role of resource management is central, also with farmers involved in technology development and dissemination.

At lunch I saw next to Minister Rao but could not get much conversation started. I hoped that it was because he had to leave for the Kisan Mela we had attended the day before and not because I had offended him by not being enthusiastic about one of his favorite recommendations, deep plowing to capture more rainfall runoff. I suggested in response to his question that this is a good short-term solution but long-term we need to move toward permanent vegetative cover, as the work of CIRAD over the past 20 years has shown. Conservation tillage has already spread to

over a million hectares in India and is used on about 1/3 of U.S. cropland, so this seems to be the direction for 21st century agriculture.

No matter what his thoughts about mine on tillage, that afternoon at the Kisan Mela we had visited the day before, Minister Rao gave a strong endorsement to use of SRI. Five thousand farmers attended the fair that day. A newspaper headline the next morning said: All Farmers Should Use SRI. Another speaker, an MP, had spoken negatively about SRI, saying that if the government promoted a water-saving technology like SRI, this would weaken its bargaining position for getting more irrigation water released from the neighboring state. (Andhra Pradesh has a standing dispute with Karnataka state over how the waters of the Krishna River should be divided.) The newspapers, which according to Satyanarayana have been very supportive of SRI, declined to report that statement.

After lunch, Dr. Subba Rao offered to join us in a field visit to an SRI farm and then to participate in a SRI farmer meeting. Unfortunately, I lost my notes from the afternoon activities, so I cannot report anything particular from the farm visit. We had a very refreshing stop at Satyanarayana's family home which en route to the farmer meeting. The farmer meeting was very memorable and no notes were necessary to recall it. We arrived in **Kollur** about 5:00 and already about 40 farmers had assembled. K. V. Rao, whom I had met during a village visit in September, greeted us on behalf of the farmers, commenting that he had heard I paid a compliment to his magnificent mustache in my September report.

He showed me two mechanical innovations that should help the dissemination of SRI. One was a weeder in which two bicycle ball-bearing assemblies had been mounted to make the weeding part turn more easily. It was a pleasure to push. The other was potentially more 'revolutionary' for SRI in that it can greatly reduce the time needed to mark the soil for regular plant spacing. The 'rake' was an advance over use of ropes tied to sticks; this is a similar step forward for labor saving.

The marker is a hollow 'cylinder' -- or set of cylinders -- made out of metal rods or aluminum tubing (to be lighter), having a circumference of 50cm or 1 meter, with cross-rods running the length of the cylinder spaced 25 cm apart (2 on the smaller cylinder or 4 on the larger one), and circular bars spaced 25 cm apart forming the open walls of the cylinder. When the cylinder is rolled (pulled) across the paddy, the intersections of the cross rods and circular bars imprint a perfectly regular grid of points 25x25cm on the soil. (The cylinder turns on an axis run through its middle and connected to handles or bars for pulling or pushing the implement.) This is not expensive to fabricate, K. V. Rao assured us, and it makes better lines more quickly than either ropes or rake. This is the kind of farmer innovation we have been expecting and counting on.

After the usual garlanding ceremonies. We got my laptop hooked up to an electricity supply and Satyanarayana showed his powerpoint presentation on SRI once it got fairly dark. Before that, Subba Rao and I gave short talks to the assembled farmers and answered some questions. (The emcee mistakenly introduced me as 'Norman Borlaug,' and was quickly corrected by others.) I concluded my remarks by asking, rhetorically and metaphorically, whether the earth is not our mother -- mother earth? They agreed, using the Sanskrit word, *bhoomata*. I then asked, whether they would leave their mother bare naked? Of course not. Then why do we leave the

earth uncovered when we plow and weed it? The tropical sun heats up the soil and kills the microbes and soil animals like earthworms, making it less productive. Possibly such vivid language will help farmers rethink their (aesthetic more than agronomic) practices of not keeping the soil protected from the deteriorating effects of sun and wind.

At the end of the meeting, the new ANGRAU leaflet on SRI in Telegu, 'released' the previous day at the fair, was distributed, with many eager hands reaching for it. The meeting had been organized by ANGRAU staff working with and through farmer organizations in the area. It was clear that there are close working relations with the farming community. As we left in the dark, I was introduced to Dr. D. L. N. Prasad who comes back to Kollur on the weekends from his plastic surgery practice in Hyderabad. He is one of the most eminent plastic surgeons in the state, though he refuses to use his skills for cosmetic surgery, the most lucrative practice. Like Kotes Rao, he has been himself promoting SRI for some months now. The efforts of Prasad and Rao gave me something to ponder during the long drive back to Guntur in the dark.

January 29 Field Visits: We left the guesthouse in Guntur at 6:30, heading east from the heart of the Krishna Delta toward the West Godavari Delta. About 9 am we passed a field where SRI had been used the previous season, very successfully. I was told that the Minister of Agriculture, whose constituency is in this area, had himself without any prompting noticed the field, having an outstanding crop right along a main highway.

About 9:30 we got to **Pedamaddali**, still in the Krishna district, and went to the home of Bhavasker Rao, a very successful farmer in the area. He told me that a retired Chief Secretary is his neighbor, and his brother was ambassador to the Soviet Union. He added that 80 families from this village are now in the U.S. Someone joked that this village "has enough intelligence to run the whole state."

After snacks, we drove to the field of Ramakrishna who had just started SRI this season, on 3.5 acres. His seeding rate was only 3.75 kg/ha. The field had not been leveled as well as it could be, so Satyanarayana gave various pointers as we walked along the bunds. The fields did not look as promising as others we had visited. There was some evidence of stem borer attack, and some brown spots on a few plants, as well as some snail damage. Still, the crop is just starting to grow. "Five days ago, the farmer was discouraged," said P.V., "but now he is happy." P.V. asked a farmer in an adjoining paddy what he thought about this new system. The farmer said nothing but made a gesture that P.V. interpreted to mean, "They are mad." In response, P.V. told him to wait 15 days more before making any judgment.

Our next stop was in **Golaipalli** where we visited the farm of Sudhakar Rao who had planted 1.5 acres with a short-duration variety, 1010, using SRI methods. The crop was 50 days old, transplanted at 10 days, but was not as vigorous as others we saw. One part of the field showed evidence of salinity problems. There were also signs of stem borer and some snail shells on the bunds. Because the farmer relies on pump irrigation, he is pleased with the reduced use of water, but his field was not that being well managed. Satyanarayana found out that although the farmer has cattle and chickens, he had not put any organic matter in the soil. "He has not been guided properly," said Satyanarayana. Farmers have gotten used to just applying chemical fertilizers. With just a suggestion, the farmer agreed to use his organic matter next season. We left that farm

about 10:30 and continued northeastward, our drive made easier by some stretches of four-lane highway.

About noon we reached Hanuman Junction, where we picked up Gopala Krishna Rao, another 'SRI activist.' Last season, he got a yield of 49 bags/acre (9.2 t/ha), up from 20-30 bags before. His costs of production were about 17,500 rupees, against a revenue of 56,500, so he made about \$1,000 per hectare, a very good return. In this season he could not grow SRI because he had no access to water, so he got a friend to try SRI. Seshajiri Rao's field at **Veleru**, said to be just 2 km from the main road, can only be reached by a much longer route, so we reached it about 12:30. His friend said that the water saving this season has been more than 50%, maybe even 70%. Because we are already an hour behind schedule, we did not give long talks to the assembled group of about 20 farmers, though we did take a little more time for an interview with the television crew that was accompanying us during the day.

Close to 3, we picked up Ramesh by the side of the main road. He was the first farmer in Andhra Pradesh to use SRI, having heard about it from Satyanarayana at a talk given April 19 last year. Sudharkar Reddy, whom I visited in September, planted his SRI just one day later, so the two are almost tied for this distinction. We turned off the paved highway and drove over several miles of difficult village roads to get to a big godown (warehouse) in **Kurillagudam**, where about 100 farmers were gathered to meet us. We had been seeing rainclouds gathering for some time, and they started to drop and then pour unseasonal rain as our tour of these fields started.

Our host farmer, N. V. R. C. Raju, had planted 110 acres of SRI rice on an abandoned reservoir bed. He tried out SRI last season and got 7 t/ha, so he decided to go large-scale, something that some critics have said was not possible with SRI. The IRRI representative in Madagascar in the mid-1990s, Mimi Gaudreau, after conceding finally that SRI did indeed achieve remarkably high yields and was indeed a new approach to growing rice, still dismissed it as limited to small scale production only, missing the point that even this could be scaled up to cover millions of acres if SRI was good for small farmers and they adopted it. Here I was seeing that SRI, with some organization and planning, can be used on a large scale too.

I was introduced to another SRI farmer who lives 50 km away. He had come to join in the meeting, describing himself one of the "SRI friends." It appears that a network has developed among farmers taking up SRI. After getting quite wet despite umbrella, we retreated to the godown, where a meal had been prepared for all of us. We regrouped the plastic chairs to be near the open door in order to have some light in this unelectrified building.

Satyanarayana discussed SRI at some length in Telegu, so I didn't have to say much about it when asked to speak. I emphasized that we expect farmers to innovate and improve the system further, and also to share what they learn with others, so that others can also benefit from its increases in productivity. I decided to raise the delicate subject of labor remuneration, suggesting that since SRI raises productivity of land, labor, water and capital, through more skillful use of plant, soil, water and nutrient management, some of these gains should go to the workers who use the methods.

I said that I couldn't suggest any specific solution, but asked them to think about how such sharing could be institutionalized. There did not seem to be any hostility to this suggestion. Perhaps if the more idealistic initial SRI users can set some favorable precedents, agricultural laborers can become beneficiaries of this innovation too. If landowners will not share the benefits, I could anticipate strikes or refusal to use the methods unless higher payment is given.

After the speeches, the ceremonies with garlands and momentos was really festive, and after being multiply garlanded, with scarves and gifts from N. V. R. C. Raju, from the West Godavari farmers' welfare association, and from the West Godavari 'SRI tech association,' I was invited then to garland Ramesh, Sudhakar Reddy and Raju in turn for their SRI accomplishments.

The lunch was a big affair with plenty of curries and rice. I saw next to a bank official who it turned out had made a loan of \$20,000 to support this crop. Raju is a successful businessman, one of the biggest chicken producers in the state, who is taken with the idea of SRI and wanted to show what could be done on a large scale.

The head of the Krishi Vigyan Kendra (farmer demonstration center) at Undi, in the heart of West Godavari district, Dr. Dandhu Jagannadha Raju, has done a good job working with farmers, getting them bank and other support. He told me that this tank bottom had been uncultivated for 5 years, so this is land being brought into production. I hope that the investment will pay off.

With the rain halted finally, we drove back to the main road to visit first the field of K. Raju, an exemplary SRI plot. It is planted with MTU 7029 variety, very popular in the region and known as *Swarna*, meaning 'gold,' having been released on the golden jubilee of the rice research station at Maruteru. This variety is responding especially well to SRI practices, with 90-100 tillers per plant expected. Already 30 days after transplanting, one of the plants which P. V. pulled up had 93 tillers, with still 10 days of tillering left, indicating that it was already in the 13th phyllochron of growth and should get into its 14th phyllochron before flowering. The dark green color of the plants showed that it was having all the nutrients needed for effective photosynthesis.

Down the road, we visited Ramesh's farm. He has 4 acres along the road and 6 acres farther away. His SRI yield last season was 9.2 t/ha, and he is aiming for 12 t/ha this season. Ramesh has been an 'SRI activist' who has gotten the new methods adopted on 200 acres in his village so far. A young lawyer who was with us said that he had planted 2 acres and will expand to 30 acres next year. One of Ramesh's neighbors who was walking with us said he would do the same. Raju whose field we had just visited said that he plans to expand from 10 to 20 acres in the coming season. An Agricultural Department officer with us, who had planted 3 acres in SRI this season, added that he expects to plant 10 acres next season. "Nothing can stop SRI now." There are 4,000 acres of rice grown in this village, I was told. They expect 2,000 under SRI next season, thanks to Ramesh's initiative and example, plus others' experience.

We were invited to have some soft drinks at a nearby house, but I soon found the mosquitoes at sunset too vicious, and these had bites that were almost like bee stings. I retreated to the vehicle. Satyanarayana told me as we left the village that this was the home of an agrochemical salesman, and he had wanted us to endorse his sprayer, models of which had been displayed around the chairs he set up for us. Satyanarayana declined rather abruptly.

We arrived about 9 o'clock in Kakinada where we spent the night at the guesthouse of NFCL, a fertilizer company. The infrastructure of 'modern' agriculture is well established in this state, with companies having prospered from the previous new technology. I hope that the new one will make these inputs less necessary.

January 31 Field Visits: Next morning, the publisher and editor of a new magazine, *The Rice Vision*, B. V. Krishna Rao and P. Chandra Sekhar, arrived before breakfast to talk about SRI. They gave me a recent issue of the magazine with a feature story, with pictures, of Dr. Erick Fernandes' visit on just 8 days earlier. Erick, a Cornell colleague and agronomy professor, was the first agronomist in the world to take SRI seriously, and he has advised several theses evaluating it. He is currently on sabbatical leave at the World Bank, so was welcomed as a Bank representative. Chandra Sekhar traveled with us most of the day. Before we could leave the guesthouse, there had to be another interview with ETV, which was covering our field visits, as was the All India Radio station based in Vijayawada.

Satyanarayana said that the Andhra Pradesh rice millers association is also supporting SRI, because it likes the improvements in grain quality with SRI, fewer broken grains and fewer unfilled grains, which means there is more outturn from a given amount of paddy rice. Recovery from SRI rice has been calculated as 75% compared to the more usual 67%. Normally there are about 25% unfilled grains; with SRI this is reduced to 2-3%, according to Satyanarayana.

On the way, we examined again the rice plant collected from Raju's field. P. V. had counted 93 tillers on it. With 10 more days of tillering, it could reach 150 or more. Satyanarayana told about how a farmer had brought him, before he visited Sri Lanka and learned about SRI, a potted rice plant with 235 tillers. The farmer had been interested to see how much tillering could be achieved by giving the plant ideal growing conditions. Satyanarayana had dismissed this as some kind of stunt, but after learning about SRI and understanding better the tillering potential of rice, he asked the farmer to try this again. The farmer brought him a plant with 240 tillers, well into the 14th phyllochron of growth.. This was 'artificial' but showed what potential exists.

At the village of **T.Kothapalli**, we entered the farm (estate) of V. Baskar Rao, an important businessman who owns Indian Shipping and Trading Ltd., which imports potash for the whole region. He has close links with the Indian Potash Association, whose regional representative, Mr. Prasad, was there to greet us as well. He had helped Baskar Rao establish a 4-acre demonstration plot, very nicely laid out. Baskar Rao took pride in showing us an 'antique' weeder, referred to as a Japanese weeder, that his father had used 35 years before when his father was pioneering the introduction of IRRI high-yielding varieties in the region. He also showed us a small electric pump, costing about \$8, that he uses to pump out any accumulated water in low-lying parts of his SRI field so that soil saturation can be avoided.

Before the program began, Satyanarayana and I were asked to plant young sweet orange trees, as a living momento of our visit. Baskar Rao told us that he collects all kind of plants from his travels and has quite a collection of flora on his estate, a peaceful retreat from commercial life. We had the usual garlanding and I was asked to garland also a picture of Baskar Rao's father.

Satyanarayana made a presentation on SRI to about 20 assembled farmers. I was pleased that the half dozen agricultural laborers who had joined us and sat in the back row of chairs were invited to come forward to sit closer to the speaker. When Baskar Rao spoke, mostly in Telegu, various English words crept in; "...basically...in between the lines...it is a fact..." Eventually he switched to English, explaining how his father had made him cycle 60 km a day during his youth to develop not just stamina but also willingness to work.

Baskar Rao said that he imports lakhs and lakhs of tons of fertilizer, but this is not balanced fertilizer. "It is a pleasure to have a trial of this type," he said pointing to the SRI plots, adding that he wants to see others take this up as well. That he has been assisted in setting up this trial by Prasad from the Indian Potash Association surprised me, but from discrete questions, I gathered that Prasad is doing this out of personal interest in improving agriculture. Baskar Rao said that he likes this agriculture more than his business, saying, "Land is permanent; business is a flying saucer." He said he looked forward to a good harvest and wanted to have a proper celebration at that time, hoping that Satyanarayana and I could come back to join them.

When asked to say a few words, I thanked Basker Rao for his hospitality and his example, adding that I agreed and disagreed with one thing he said. "Land may be permanent, but soil is not." If we do not manage soil well and properly, we can kill it or at least cause it to deteriorate. I said that most farmers have come to attribute all improvements in agriculture to better varieties, always asking "What variety is that?" rather than "What practices gave you that result?" We should be interested in things like spacing, plant age, water management, etc.

A farmer from the village of Mukkamala which I visited in September, and who brought me some nice pictures of that memorable visit, gave the vote of thanks, saying that they "promise to extend SRI." The photo display promoting SRI that I was asked to inspect after the meeting closed was, I noted, prepared by the Indian Potash Association.

As we drove to the next field visit, Satyanarayana commented that the executive engineer of ANGRAU who comes from this area has motivated 20 farmers to take up SRI here. This prompted a discussion of motivation. I suggested that the spread of SRI seems to differ from that of the Green Revolution. To be sure, here in Andhra Pradesh, thanks to Satyanarayana, SRI has official support and is progressing with institutional backing. But we are seeing efforts like those of this engineer and of Ramesh, Kotes Rao, Dr. Prasad and others. For the most part in countries around the world, SRI is being spread by volunteers, who are motivated by a sense of altruism, something commonly thought to have atrophied in the present world. This both contributes to and is propelled by the enthusiastic response of farmers to SRI.

P. V. Satyanarayana commented that the Green Revolution in India had been propelled by farmer enthusiasm too, but only by a desire for dwarf variety seeds, which farmers would even steal to get for themselves. The other parts of the Green Revolution, the fertilizer and chemical inputs, took a longer time to disseminate and had to be promoted by government and company agents. I observed that the Green Revolution's spread was driven largely by self-interest, seeking to make innovations that would benefit one's self.

SRI, of course, also offers individual farmers dramatic improvements in production and profitability, but many people, farmers and non-farmers, are promoting it for the sake of others and for the environment, rather than for themselves. As far as I know, there were fewer similar efforts by farmers to spread the innovation to other farmers in the Green Revolution. This does not make SRI better or ensure its success, but it means that this innovation should be looked at somewhat differently.

The next farmer we visited is an organic farmer. We were surprised to find him spraying his field with a solution of EM (Effective Microorganisms) prophylactically to prevent stem borer infestation. Satyanarayana and I know of neither evidence nor theory to support this, but the farmer thinks it will be beneficial. We suggest he leave a portion of his field unsprayed to see if there is any effect. P.V. suggests this will be, for us, a no-cost experiment.

Our next stop is in **Somidevivaripalem** where S. B. Narayana, also an organic farmer, who reminded me that we had met during my visit to Achanta in September. He has a sign up welcoming Prof. Narman Huffaf. Close. His SRI crop last season, with no pesticides, had some stem borer attack before harvest, and he got only 32 bags per acre (6 t/ha), but this was a 70% improvement over his previous yield of 18-19 bags per acre. Satyanarayana points out to the farmer that he is still keeping too much water on his field as the roots of his rice plants are more brown than the roots we usually see on vigorous SRI plants.

Narayana shows us the weeder he has designed, with a sideguard to hold plants away from the wheels. It is not heavy and looks very practical. More impressive is the marker he has built, to mark 9 rows at a time. But constructing his implement from three cylinders, each marking three rows, he can mount a U-shaped handle on it so that one person can pull it, rather than two, as in the previous models we have seen.

After garlands and snacks, I was told that the laborers wanted to have a picture taken with me. A group of a dozen women, dressed in their best saris, and three men plus some children are standing in a group. I ask them, through P.V., what they think of SRI methods. They smiled very positively and several said, it is good. I asked them if it is more difficult, and they said, only at first. They volunteered that at first it took 30 days work to plant an acre, but now only 8-10 days are enough. (This is presumably not something in their interest, but they are not hesitant to endorse SRI.) I ask how they the plants in the soil, and a dozen hands show how they pick up the seedling and lay it in.

As we drive back through the village, I see a statue in honor of India's first untouchable leader, Ambedkar, and a few hundred meters away, a statue of Jagjivan Ram, another low caste leader. It appears that in this village, lower class groups have more pride and maybe also more power.

It is an hour's drive to the home of N. Mruthunjayudu in **Mogilipalem**, where a large group is waiting for us to have lunch with them. The house has a TV satellite dish on the side and clearly this is a more prosperous farmer. One of his neighbors shows me a notebook on SRI, with pictures, newspaper clippings, a calendar listing field operations from nursery sowing to harvesting. It is remarkable how often I find farmers with pictures of their fields, their plants, their inventions. SRI is eliciting a pride that is quite wonderful to see.

Since it was already 3 o'clock, we had lunch before walking to see the SRI plots, 4 acres, planted with two varieties of seedlings 7-8 days old. The crop looked good, but we were less impressed with the weeder design that Mruthunjayudu showed us. It was built to weed four rows at a time, but was too heavy, and so was cut into half, for two-row weeding. But even so, it is much more difficult to maneuver than the other weeders we have been seeing. Satyanarayana and I discussed how we could have a systematic evaluation of different weeder designs by farmers, to be able to recommend which designs are best, for different soil and other conditions, to be sure, as no single design is likely to be best for all situations.

We left at 4 and got to the farm of S. Lakshmana Reddy in **Ramavaram** about 5:15. He had the best organized SRI plots we have seen on the whole trip, with maps of each plot, identifying the variety planting and area measured to the hundredth of a hectare. After garlands, we walked around his 12.3 acres. His farm is next to a large chicken farm, but he was not using any chicken manure to enrich his fields. When Satyanarayana visited this farm a week earlier with Erick Fernandes, he suggested that Reddy procure manure and compost it to further improve his soil.

This Reddy is the farmer who first 'invented' the cylindrical marker for spacing young seedlings. We saw his original weeder, the idea of which has been picked up by other farmers and modified, for better or for worse. That the concept has spread so far within Andhra Pradesh within one season indicates how much communication there is among SRI farmers.

The rice plants were aligned more evenly than in any field seen so far and looked very good. Some had already more than 70 tillers at 30 days of age (transplanted at 8 days, 22 days in the field). This is MTU 1071, the increasingly popular variety that P. V. Satyanarayana has developed, so the plants still have 15 days of tillering left. P.V. asks the laborers who are pushing weeders swiftly and skillfully up and down the rows if they ever thought when they transplanted the tiny seedlings that such growth was possible, and they all responded, no.

Satyanarayana noticed fertilizer granules on some of the fields, and he explained to Reddy that when the crop is such a rich green, there is no need to add inorganic nutrients. Indeed, such additions are likely to interfere with the beneficial activity of soil microbes, citing the example of one SRI farmer who had 'spoiled' what was likely to be a very large harvest by top-dressing his vigorous crop at panicle initiation stage. There was further tillering and a low rate of effective tillering, contrary to the experience of other SRI farmers who relied on organic nutrition for their plants.

We left as it got dark, needing to catch the train back to Hyderabad either at 7:30 in Kakinada or at 8:00 in Satamkot Junction. The latter seemed the safer choice, and we got there with half an hour to spare. Satyanarayana and I had sleeper berths that enabled us to get a good night's sleep, arriving next morning at 7:30 in Hyderabad.

January 31: After breakfast at the ANGRAU guesthouse, I worked on this report, trying to put on paper what I had seen and heard, so that others could share vicariously in the remarkable experience I had had in these 10 days. This was not standard research, with pre-set questions, but rather a field investigation, looking for whatever information, positive or negative, concerning

SRI could give a more complete understanding of its opportunities and limitations. When one goes into the field looking for particular things and tries to standardize all the data collected, it is easy to miss things that are emergent or idiosyncratic.

Systematic data are being collected by TNAU and ANGRAU that will add to our quantifiable understanding of SRI. These analyses will be necessary for drawing firmer conclusions about what SRI can contribute to farmers' well-being, to agricultural development more generally, and to environmental integrity. But since SRI is 'still new,' as I stressed with all the farmer groups I met, formative evaluations are more relevant than summatory ones, to use the jargon of evaluation science.

Mid-morning I got a call from Vijay Raghavan, managing director of Sathguru Management Associates, a consulting firm that has worked with Cornell on a number of projects. In May 2003, he helped set up high-level meetings with agricultural administrators in Tamil Nadu and Andhra Pradesh to start building interest in SRI. He had recently been in a meeting in Chennai where the Secretary of Agriculture had spoken very positively about SRI dissemination in that state, confirming what I had heard from TMT.

At noon, Dr. U. Prasada Rao, general manager for research and development of Nuziveedu Seeds Ltd., came by the guesthouse to talk with Satyanarayana and me about SRI. He is taking an active interest in it, wanting as a plant breeder to assess different varietal responses to its methods. He said he would set up systematic trials in the next season, which will be a real service for making SRI more productive for farmers. Satyanarayana underscored that SRI results from all 22 districts have been good, so there is no question that the methods work across the whole range of soil types, except for saline soils. Some of the best results have come on soils that are generally regarded as poor. Spikelets are up to 100% filled whereas often they are only 40% filled. They have counted as many as 750 spikelets on one panicle of MTU 1071.

At 1 o'clock, Satyanarayana and I met Mr. P. S. Sharma, Secretary of Agriculture, for lunch. He had to leave by 2 for a videoconference with the Chief Minister, but we had time to talk about the field visits and what next steps should be to gain wider acceptance of SRI, within the government and by farmers.

We then visited Dr. K. S. Prasada Rao, Minister for Health and Family Welfare, a very influential member of the cabinet who comes from the Krishna Delta. He has been following SRI for some time and also gave us much encouragement. He suggested that Satyanarayana prepare a summary report from this season's results to take directly to the Chief Minister. We do not want this to become a typical top-down operation, but high-level support helps to get the bureaucracy to cooperate. Satyanarayana would like in the next season to have a whole command area use SRI to see how much water saving can indeed be accomplished with SRI methods. Individual farmers may make savings on their own fields, but this does not aggregate to larger-scale savings unless all are operating on the same water delivery schedule.

We agreed that any such effort should involve SRI farmers who have made the methods work well for them, with farmer-to-farmer communication leading the effort, and with government guarantees to farmers that they will be compensated for any losses. So far, from hundreds of

trials reports this past season, no farmers have experienced any loss with SRI methods. In cases where the yield was low, such as 3.5 t/ha, this was a definite improvement on the usual yield, 2.6 t/ha, so the offer should not cost much or even any money.

This report would be much longer if more detail were included. What is reported are things that can give readers a concrete, often vivid understanding of the progress of SRI in these two major rice-growing states of India, noting problems or qualifications as they have surfaced. As noted above, this report is not a substitute for systematic data collection and analysis, but a rather a qualitative picture, highlighting data reported by farmers and agricultural professionals. There were discussions with the whole gamut of stakeholders, from farmers to top government decision-makers. SRI has acquired its own momentum in these states based upon observed results so that the challenge now becomes to find the best ways to make knowledge about SRI available to farmers and to improve the practices further, so that they can meet better the diverse objectives that SRI can serve.