

REPORT OF FIELD VISITS IN ZHEJIANG AND SICHUAN PROVINCES, CHINA
July 28-August 3, 2005 – Norman Uphoff

Zhejiang Province, July 28-31

On a Saturday morning at 8 a.m., July 30, Dr. Lin Xianqing and Ms. Zhang Yuping from the China National Rice Research Institute (CNRRI) picked me up from the hotel where I was staying in Hangzhou having arrived the evening of the 28th and having had long discussions with Lin about joint publications on the 29th. Lin has been evaluating and promoting SRI for several years now and recently published an article in *Field Crops Research* on the physiological effects of alternative water management regimes. Ms. Zhang is also studying water management effects for her PhD thesis. Dr. Zhu Defeng, head of SRI work at CNRRI and coordinator of the national SRI network in China, was not with us because he is on a six-month assignment in Spain.

We drove together to Xinchang County, about 150 km southeast of Hangzhou. As we started out, Lin told me that SRI is spreading in Zhejiang mostly because farmers like it once they see it and try it for themselves. Scientific evaluation is useful and positive, but it is not driving the spread of SRI. There is considerable convergence, he said, between SRI and certain trends in rice production that began already in the 1990s, to lower the density of plant populations and also to reduce seedling age. There is also growing concern over the build-up of nitrate in water supplies due to the overuse of nitrogen fertilizer. Some annual application rates (for two crops) are exceeding 500 kg N per hectare. I noted that in such areas, groundwater nitrate levels are now reported to exceed 300 ppm, which is six times more than the level that the U.S. Environmental Protection Agency considers to be the threshold for concern (50 ppm).

We discussed some IRRI research which showed that rice yields can be 40-70% higher when the supply of nitrogen that plants get is split between nitrate and ammonium forms, rather than being provided all as ammonium (Kronzucker et al., *Plant Physiology*, 1999). Under flooded, i.e., anaerobic soil conditions, ammonium-N is the predominant form available; with alternate wetting and drying, as recommended with SRI, both forms become common. This could be one factor contributing to the better performance of SRI methods.

In Zhejiang province, the average yield is 430 kg/mu, Lin said, about 6.5 t/ha. With SRI methods, farmers have reached 800 kg/mu, almost double (12 t/ha). As we turned off the main highway into Xinchang City, we passed an industrial park advertising itself as “the largest aluminum wheel manufacturing center in Asia,” a reminder that rural area industrialization is proceeding rapidly and that agriculture must compete with industry for labor and other resources.

At Cheng Tang, the first village visited, we were met by Dr. Chai Li Ming, director-general of the Xinchang Agricultural Bureau (Department), and other staff by the side of a field. Chai recalled that an American researcher, an economist from Stanford, had visited him in 1992 (probably Scott Rozelle). The SRI crop that we inspected in the field, still in its vegetative growth stage, looked very vigorous. The plant density was 9,000/mu compared with 12,000/mu now recommended. The seedling age had been 25 days instead of 35 days. Lin explained that at the higher elevation here, temperatures are lower so seedling growth is slower. This means that a 25-day seedling here is not as old biologically as at warmer, lower elevations. I agreed with him,

however we also agreed that it would be good to experiment with still younger seedlings here to see if this can be beneficial.

We pulled up one of the plants to examine its roots, something not done often. Everyone was impressed by the extent of root growth, except me. The color was not as white as it could and should be, indicating there is still more flooding (and hypoxia) than desirable. This is their first year for this particular demonstration, and all agreed there should be more variation in the trials, to see what will be optimal for these local conditions. As there was not much more to see and the sun was scorching, we drove back to Xincheng City for a splendid lunch at a favorite restaurant.

After lunch, we drove 20 minutes in a different direction from the city to see an SRI demonstration plot at Dong Cheng village. This had been planted at 40x40 spacing, and the canopy had filled in completely, with no weed growth. The color of the SRI field was a much richer green than that of the adjacent field planted with the same super-hybrid variety, indicating higher chlorophyll content in the SRI leaves. SRI plants were 5-10 cm taller than the controls, and the officials with us said that there was less disease. Since both plots were managed by the same farmer and had the same soil, this was a strikingly visible demonstration of the differences that SRI management practices can make.

We drove next to Tien Tai county and to Bu Tou village, which I had visited almost a year before. With us was Mr. Xi Tianwei, deputy director of the Tien Tai Technical Extension Center, and several of the staff who are working with him to promote and evaluate SRI in the county. Nie Fu Qu, the farmer-leader in Bu Tou whom I met the previous August, met us at a signboard that he had posted alongside his SRI field, so that any visiting farmers could learn details about his experiments. He said that at least 100 farmers had come to see the fields. On the signboard was a copy of the newspaper article on my previous visit, with a picture.

The most prominent information on the signboard, which Lin translated for me, was a table giving yields from different trials that Nie had conducted (given in jing per mu: a jing amounts to half a kilogram, while a mu is 1/15th of a hectare, or about 1/6th of an acre):

Cultivation method	Direct-seeding by machine	Direct-seeding by hand
Standard tillage	1507.6	1340.0
No-till cultivation	1475.6	1339.7

Next to the table on the signboard was a hand-made technical drawing of the direct-seeder that Nie had designed and built himself, with a small picture of it. The implement plants germinated seeds in a rectangle pattern, 30.5 x 22.3 cm, which gives a plant population of 9800 plants/mu.

These numbers convert into remarkable yields: 11.3 t/ha for the direct-seeding by machine on tilled soil, and 11.1 t/ha with no-till. The 4% difference is probably less value than the cost-savings obtained from not having to plow. Also, no-till yields usually increase over several years as soil biota get better established. So this first-year result suggests that a very promising innovation. For the direct-seeding done by hand, there was no difference in yield between till and no-till (both 10.1 t/ha). That the machine-seeding method gave 11% more yield than did hand-seeding should make the method attractive to farmers in addition to the labor-saving it achieves. Paddy yields in Tien Tai usually average about 6.5 t/ha, so this difference with SRI is substantial.

Nie produced the highest yield in Zhejiang province last year, Lin told me. Both are very pleased with this year's crop, and Nie he thinks that the yield may be even higher than that in 2004. Since the crop is still in its vegetative growth, it is difficult to make any exact prediction. There was practically no indications of pest or disease damage, and the plants' color was dark green, with upright leaves, and little or no senescence. As there was light rain during the visit, we spent only about half an hour in the field, afterwards having slices of a ripe watermelon that Nie cut up for us. From there we went to the nearby villages of Shan Tou Shao and Xi Bianzhang, about 15 minutes' drive from Bu Tou.

A number of farmers were standing near a large signboard that had been erected to describe for all who came by their fields their experiment planting SRI on a large scale. The two villages' 428 families, having seen the SRI results at Bu Tou, decided to planted 1052 mu with SRI methods (65.75 ha) with 14-to-20 day-old single seedlings at 30x25 cm spacing. The growing plants looked very good, and I got two farmers to pull up one of the plants to examine its roots. (The resistance was more than one could overcome easily.) Everyone remarked on the size and color of the roots, something I suggested always be examined.

I asked one farmer what people in the village think about SRI. His first comment was that the sparser planting saved them labor, and they are glad to save water also. He said the crop is growing better than last year's crop. I asked what is the most difficult aspect of SRI, and he said water management. It takes greater effort to regulate the supply rather than just keep the field flooded all the time. This was agreed by the other farmers standing around. When I asked again about difficulties, one volunteered that their work in handling young seedlings could be made easier if they used plastic sheets to grow the seedlings on and then for transporting these to the field, a sensible idea. I asked a third time about difficulties, and this time another farmer said that the conventional method of rice management and SRE have 'similar difficulty.' They did not see any barriers to using the new methods.

The farmers took me to see one plot that had been sown with the 'triangular method' developed in Sichuan Province (by Liu Zhibin at Meishan). This innovation uses half as many hills as with usual SRI, but with three plants per hill, set out in a triangular pattern with about 7 cm between the three plants. This increases total plant population by 50% without losing the wider-spacing effect. Also, a rectangular rather than a square pattern of hill spacing is used. The plants looked very vigorous, but their canopies did not cover the area as well as the square-planted SRI. There was still time for more tillering, however, before panicle initiation, so there could be more coverage. In any case, no assessment of productivity can be made until harvest time, when we will know the per-square-meter yield, which is the real test -- not per-plant production.

When we got back to the signboard, an elderly gentleman, quite loquacious, greeted us. He introduced himself as the village school teacher and proudly noted that he was older than I am. He proudly told us that he had himself transplanted 6 mu (about 1 acre) with the new methods, which he said he liked. I asked him whether they were encountering any difficulties with SRI, and he insisted, like the others, that they have had no problems. He said that last year in these two villages they harvested 500 kg/mu (7.5 t/ha); this year they hop for 700 kg yield (10.5 t/ha).

That would make a very large difference for the families' welfare, especially if they are saving water and are cutting cash costs, without any increase in labor expenditure.

It was almost 5:30 by this time, and Mr. Xi led us back to Tien Tai City where he hosted a fine dinner at a large hotel. This made the long drive back to Hangzhou, arriving after 10 o'clock that evening, less challenging. These two counties, which represented only part of the evaluation and promotion efforts that the CNRRI is making in Zhejiang province, were the most accessible given my limited time. From the various conversations, I could understand better why Dr. Lin talked that morning about farmer enthusiasm. This is encouraging local officials to become more actively involved with SRI. Many challenges remain in adapting the ideas and practices to local conditions, and even more in developing through systematic scientific research some solid explanations for the effects seen. But SRI is clearly gaining momentum in Zhejiang.

Sichuan Province, July 31-August 3

On Sunday, I flew from Hangzhou to Chengdu, being met at the airport by Dr. Zheng Jiaguo from the Sichuan Academy of Agricultural Sciences' Crop Research Institute. He has been the most active researcher engaged with SRI in this province, also working with county agricultural bureaus to get SRI use extended within Sichuan. He reminded me that this was my fourth visit to his province since 2002.

He had planned to have an 'international seminar' on SRI on Monday at the SAAS headquarters for a number of visitors from other countries. But due to visa problems, the arrival of a team of seven Pakistani rice scientists was delayed a day, and the planned visit of a number of Indian and Vietnamese scientists was having to be postponed for the same reason. I thus had most of a day to work on articles and to confer with Zheng on a joint publication on SRI before attending, that evening, a welcoming dinner at a Muslim restaurant near the hotel with the Pakistani team that had arrived by then. (The visit was part of a government-to-government exchange program under which Zheng had visited Pakistan the previous year.)

At the seminar Tuesday morning, the head of the delegation from Pakistan, Dr. Raiz Mann, outlined issues facing the irrigation sector in his country. The most serious was a serious and growing shortage of water supply. When Mann listed areas for collaboration between the SAAS and the Pakistan Agricultural Research Council, he listed SRI second, saying that they had learned about this from Zheng's visit and they were very interested to learn more about it and to see it for themselves. My scheduled presentation on SRI conveniently followed Mann's talk, and then Zheng gave a powerpoint presentation focusing on SRI in Sichuan.

Wednesday we made a field trip to Guanghan county, where Zheng oversees a research and demonstration station that was set up and is funded by the county government. A large part of his program focuses on SRI, although this is combined also with evaluation of different rice varieties and experiments on 'rational management (retention) of crop residues' as part of a 'conservation farming' thrust. (Peter Hobbs from Cornell, who previously headed up CIMMYT's efforts in South Asia to develop and promote 'conservation farming' in that region, often characterized as 'no-till agriculture,' had visited Chengdu just two weeks before me.) At the station, they are looking also at efficient fertilizer management, integrated pest management (IPM), and diversified crop rotations.

The most interesting example of the latter (for me) is the SRI rice-mushroom rotation being spread in Sichuan. One mu of mushrooms can produce a net income of \$120 a year (or \$1800 per ha). Straw is the main substrate (and constraint) for growing mushrooms. Since rice produces much more straw with SRI methods, these permit farmers to double their mushroom area, e.g., to sustain 1 mu of mushrooms, they need only 5 mu of rice area, instead of 10 mu).

The Chinese version of SRI is not yet “organic,” because chemical fertilizer is still used, though less. Agrochemical use is reduced because it is less necessary. This improves growing conditions for mushrooms since their spores do not do well with excess nitrogen or with agrochemical residues in the soil. This encourages farmers to cut back on chemical inputs to their rice production since producing mushrooms is their more profitable than rice. “With SRI, the farmers do not have to wash their field,” Zheng told us, i.e., do not need to leach nutrients and chemicals with heavy pre-season applications of water.

Also, the raised beds in which the mushrooms are grown constitute very fertile soil for the SRI rice crop, so spacing of hills is usually 40x45 cm. Here the ‘triangular method’ is used, with three plants per hill but fewer hills than in ‘standard’ SRI. There is little problem with pests and diseases, although stem borer can be more serious because the SRI crop is ‘more green’ and the plants grow more lavishly, attracting this pest to them. Since the SRI plants have more tillers, the damage is not significant, however, at Guanshan, they are doing three sprayings for stem borer control. This represents a definite reduction in chemical use, Zheng said.

The SRI plots that we visited and walked through were doing very well, most still in their vegetative growth phase. Zheng has found that the hills can easily have over 100 tillers, but he is concerned about having too many unproductive tillers at the time of harvest. Accordingly, he drains and dries his SRI plots at midseason, at about 45 days. My own theory on this, based on what I have seen elsewhere, is that the problem of having a large number of unproductive tillers is a result mostly of applying more inorganic N than the plants need. If this excess is curtailed and if N is provided mostly through biological processes in the soil, this problem is minimal. However, this hypothesis has not been systematically tested in China (or elsewhere).

Zheng’s field trials have shown 8.5 t/ha yields with conventional ‘modern’ practices, 10.2 t/ha with ‘standard’ SRI practices, a 20% increase, and 13.5 t/ha with his ‘modified’ SRI, a 50% increase. The triangular method of planting hills but with wider spacing between hills gives a higher population than in a standard square pattern with one plant per hill. When asked about the expected yield from these plots, he said they should give >11 t/ha. The duration of the variety being used is 158 days, but he expects the SRI crop to mature in <152 days. (In Nepal we have seen as much as a 15-day reduction in the crop cycle. This is something worth investigating.)

After walking through the fields and getting the obligatory mud on our shoes, we met in Zheng’s office in a building constructed by the county government. (He also has a one-room apartment there so he can reside there for some period of time; the drive from Chengdu is over an hour.) The executive of the county, who had welcomed us when we arrived and accompanied us through the fields, stayed with us throughout the visit to show the authorities’ support and concern for rice improvement.

The station itself has about 10 ha of land, but trials are also conducted off-station on different soils. Farmers are taking up SRI, both Zheng and the governor said, although no numbers were given. They are also working SRI into cropping systems with vegetable production, though mushroom-rice rotation is the most popular, given its financial returns. Farmers' rice yields in this area average about 555 kg/mu (about 8.3 t/ha). Demonstration plots with 'modern' methods have reached 10 t/ha, but SRI plots have averaged 11 t/ha, with some producing considerably more. Farmers are very interested in labor-saving machinery that can save them time within the season and also between seasons since crops are planted in close rotation. Zero-tillage cultivation is becoming popular, and farmers understand the importance of good field leveling to save water.

When I was asked to make some comments, I suggested that possibly they are still using more water than needed. I expressed regret that we had not pulled up some of the SRI plants while in the field, to inspect their roots. As I should have anticipated, as we were leaving the meeting, several station staff brought me SRI plants that they had gone out and uprooted for inspection.

The roots were not as large as I would have expected, though Zheng said the plants had been dug up quickly and did not have their full root system. Also, the color of the roots and culm was not as white as I like to see in SRI plants. The staff were disappointed that I was not fully satisfied with their plants. But to me this had a positive side, indicating that with better water management there is still scope for considerable improvement in their SRI results. Every chance that I get, I encourage farmers and researchers to examine rice plant roots, even just with quick visual inspection. The roots that I saw during the Zhejiang visit were healthier and more impressive than these. However, as I saw from my shoes, the on-station soils are very heavy clay, and this could be contributing to root hypoxia.

As the bus pulled away from the station, Zheng pointed out a field where the farmer had taken up SRI practice just from watching what was being done on-station. He expressed optimistic that enough benefits have been demonstrated over the past three years that farmers, scientists and officials will now make more efforts to capitalize upon the opportunities that SRI concepts and practices offer. A number of adaptations to local conditions are being made, but this is desirable and expected with SRI. It should not be treated as a fixed (finished) technology, to be applied in a uniform way across widely varying localities. There are a number of other areas in China where SRI is being tried out and now extended, but Zhejiang and Sichuan may be the two provinces where there is most institutional support and demonstrated farmer interest.