REPORT ON 2ND NATIONAL SRI SYMPOSIUM, AGARTALA, TRIPURA STATE, INDIA, October 3-5, 2007 – Norman Uphoff

Summary Observations

1. This Symposium -- hosted by the State Government of Tripura and co-sponsored with the Indian Council for Agricultural Research's Directorate of Rice Research (DRR), the Ministry of Agriculture's Directorate of Rice Development and the Central Rice Research Institute, the National Bank for Agriculture and Rural Development, the Andhra Pradesh state agricultural university, ANGRAU, the Sir Dorabji Tata Trust, and the World Wide Fund for Nature (WWF) -- brought together people from a very diverse set of institutions, indicative of the **breadth of interest and support** for SRI that is now evident in India.

2. Researchers, farmers, NGO personnel, policy-makers and others presented data and experience that show SRI making a **great variety of improvements**, not just in yield, but also in water saving, cost reduction, more profit, crop resistance to biotic and abiotic stresses, improved grain quality, less time to maturity, higher milled rice outturn from SRI paddy, and even labor-saving.

3. There continues to be **wide variation in yield increases**, often with lower yields reported by researchers in on-station comparison trials than the yield increases reported from farmers' fields, which are generally at least 25-50%, often 50-100%, and sometimes 100-200% or more. Achieving these gains with less cost raises the profitability of rice production, which is more important to farmers than is yield per se.

4. State governments and the central government, encouraged by the **growing consensus on these advantages**, have begun supporting SRI extension, expanding upon what civil-society organizations have been doing to promote SRI. The GOI's **National Food Security Mission** has set a goal for SRI extension to 5 million hectares over the next 5 years (see postscript). The Tripura government has already achieved 8% of the state's rice area under SRI methods. The Bihar government will fund SRI extension to 25,000 poor households by an NGO that has increased the number of farmers using SRI in Eastern India from 4 to 6,500.

5. Village visits and data confirm that SRI methods are **being taken up by poor households** with increasing effectiveness and eagerness (see reports from Bihar and Jharkhand; also data from visits to tribal communities in Tripura). Larger farmers are adapting SRI practices so that they too can benefit from the departures SRI makes from standard cultivation methods.

6. There were reports from some districts of Andhra Pradesh of **disadoption of SRI.** The reasons were not clear, but they need to be followed up. Possibly there is some 'push back' emerging from interests that are disadvantaged by the uptake of SRI methods.

7. **Pest and disease resistance** with SRI methods, frequently reported, has been documented by researchers, as is the fact that certain pests, particularly leaf folder, can increase with these methods. An interesting evolution of SRI practice is the application of its methods to the **production of other crops**, such as wheat, sugar cane, mustard, and finger millet (ragi).

Introduction
This report is a personal perspective on the Symposium – not a substitute for the formal report that is being prepared by rapporteurs for the respective sessions. Their report will be posted on the web, with the URL given on the SRI web site that CIIFAD maintains on behalf of the international SRI network (http://ciifad.cornell.edu/sri/).

October 2 - Tuesday
My wife Marguerite and I flew straight from the U.S. to Tripura with a short overnight stay in New Delhi, arriving in Agartala this morning. En route we met up with **Dr. T. M. Thiyagarajan** in the Calcutta airport. TMT was the first Indian researcher to start work on SRI as early as 2000, while director of the Centre for Soil and Crop Management Studies at Tamil Nadu Agricultural University (TNAU). He is now director of TNAU's Rice Research Center at Tirur near Chennai. While boarding the plane to Agartala, we also met **Ngo Tien Dung**, director of the National IPM Program in Vietnam, who has given leadership to SRI evaluation and spread in that country, along with **Le Mau Toan**, deputy director of the Ministry of Agriculture and Rural Development's Plant Protection Department, and **Nguyen Van Phuc** from the Centre for Sustainable Rural Development (SRD), an NGO beginning to work with SRI.

Upon disembarking in Agartala, we met **T.M. Radha** from the Agriculture-Man-Environment Foundation (AMEF) in Bangalore which works in several states of southern India. As associate editor of *LEISA-India* magazine, Radha has been tracking SRI for some years now. With us were also two participants from the national IPM program in Cambodia, and two Moroccans attending with support from WWF because water-saving is increasingly important in that country. It was evident that this would be a gathering of diverse collaborators, university, government and NGO, with complementary international participation.

Waiting for us inside the airport was **Dr. Baharul Majumder**, who more than any other person was responsible for our being in Tripura. In 1999, he obtained a blurry photocopy of our first paper on SRI. It was so faint that he had to fill in many of the letters with a pencil to be able to read it. The ideas intrigued him, and over the next 2 years he did his own trials with SRI methods, adapting them to the humid conditions of Tripura state. In particular, he had to work out effective but simple means for keeping fields reasonably well-drained despite heavy rainfall (average annual rainfall of 2500 mm) since SRI requires aerobic soil conditions for best results.

Between 2002 and 2005, through Baharul's initiative and leadership, the number of farmers using SRI methods went from 44 to 880, and then with strong support from the state's Secretary of Agriculture and its Minister of Agriculture, as well as from its Chief Minister, this number rose almost a 100-fold over the next two years, reaching >70,000 farmers in 2007. A team assembled by WWF that visited Tripura in April this year was so impressed by they saw and learned (http://ciifad.cornell.edu/sri/countries/india/intripurarpt0407.pdf) that it was agreed all around that the next all-India SRI symposium should be held in Agartala – so that people from all across India, and from other countries, could see and learn from this state's example.

A press conference was held at 6 p.m. Tuesday evening in the state government's administrative center, chaired by the Commissioner and Secretary of Agriculture, **Dr. G. S. G. Ayyangar**.

About a dozen journalists from newspapers and television were there. First to speak was **Dr. Biksham Gujja**, Senior Policy Advisor of WWF, who has taken many initiatives to bring SRI to the attention of policy-makers and agriculturalists because of its merits of improving rice production while saving water. SRI can reduce competition between agriculture and natural ecosystems for this scarce resource. I spoke briefly, as did also **Dr. B. C. Viraktamath**, project director of the Indian Council for Agricultural Research's Directorate of Rice Research (DRR) in Hyderabad, and **Dr. Muazzam Husain**, national SRI coordinator in Bangladesh, who was heading a delegation of eight persons from his country which borders the state of Tripura.

After the press conference, an informal dinner for Symposium participants was held at the State Institute of Public Administration and Rural Development (SIPARD) in Agartala, where all the Symposium events were held. The first persons whom I met upon arriving at SIPARD were two farmers who have given leadership for SRI in their respective states, **K. V. Rao** from Andhra Pradesh, and **K. V. Krishna Rao** from Karnataka. Clearly the Symposium would have articulate farmer participation. Also at the dinner was **Dr. M. C. Diwakar**, project director for the Ministry of Agriculture's Directorate of Rice Development (DRD) in Patna. Like Dr. Viraktamath, he had played a prominent role in the 1st National SRI Symposium, held the previous November in Hyderabad. This is in Andhra Pradesh state situated in the south of India, contrasting with the northeastern region where Tripura is located.

At that first Symposium I had met **Dr. Anuradha Saha** from the Shere-i-Kashmir University of Agricultural Science and Technology in the northernmost state of Jammu & Kashmir. Her poster presented there reported on results of her first year of SRI trials. This year she was attending with more results to report -- and with the rest of her family, including her daughter. Both her husband **Dr. Vijay Bharti** and father-in-law **Dr. J. Prabhakara** are also members of the agriculture faculty at SKUAST and are now involved with Anuradha in her SRI work in Jammu.

Also there was **Abha Mishra**, a newly-appointed lecturer at Rajendra Agricultural University in Bihar, who is completing her thesis on SRI for a Ph.D. from the Asian Institute of Technology in Bangkok, using data from greenhouse experiments at AIT and farmer-participatory research in Cambodia; and **Karma Lhendup** from Bhutan, who has started SRI work in that country from his teaching position in the College of Natural Resources there. Abha and Karma are two of the young professionals most active in advancing SRI science and practice internationally.

At the dinner, there were many Indian colleagues who had been at the Hyderabad symposium, or who had gotten involved with SRI since then and with whom I had been in contact by e-mail. With over 250 participants attending the Symposium, it was impossible to talk with all previous acquaintances and/or to get acquainted with all the others with whom I would like to have talked. This was an indicator of SRI's progress in India, but unfortunately it was at the same time a personally discomforting one.

October 3 – Wednesday

Because the Chief Minister could not come until late morning, the Symposium began with a Pre-Inaugural Session on **Research Experiences on SRI in India**. This first session was chaired by **Dr. U. Venkateswarlu**, Principal Secretary for Tripura's Department of Agriculture and Animal

Science, with **Dr. R. B. Sharma**, Director of Research for Indira Gandhi Agricultural University in Raipur, Chhattisgarh state, serving as co-chairman.

The co-sponsoring organizations were introduced in turn, starting with the **Tripura Department of Agriculture**. It was noted that already about 8% of the state's rice area is now cultivated with SRI methods. There are many large contiguous areas of 30-50 hectares where all the farmers are using the new methods. Two years ago, the extent of SRI use was a fraction of 1%. Other Symposium co-sponsors included:

- The **Directorate of Rice Research** (DRR) in Hyderabad, part of the Indian Council for Agricultural Research (ICAR), and
- The **Directorate of Rice Development** (DRD) in Patna of the Ministry of Agriculture;
- The **Central Rice Research Institute** (CRRI) in Cuttack, interested particularly in upland/rainfed applications of SRI;
- The **National Bank for Agriculture and Rural Development** (NABARD) based in Mumbai;
- The **Acharya N.G. Ranga Agricultural University** (ANGRAU) in Hyderabad, the state agricultural university for Andhra Pradesh;
- The **Sir Doraji Tata Trust** (SDTT) based in Mumbai; and
- The **World Wildlife Fund for Nature** (WWF) through its Dialogue Project with the Intl. Crop Research Institute for the Semi-Arid Tropics (ICRISAT) in Hyderabad.

The latter two agencies provided most of the financial support for the meeting, with the Tripura state government making large in-kind contributions. It was noted that WWF has supported first SRI evaluation and then dissemination since 2004, working together with ANGRAU, DRR and several NGOs. SDTT has recently identified SRI as an effective technology to increase food security in India and is supporting the SRI work of 10 agencies in the states of Madhya Pradesh, Bihar, Chhattisgarh, Jharkhand, and West Bengal. That the first Symposium had 4 co-sponsors while this Symposium had 8 was pointed to as an indication of SRI progress in India. The number of participants was over 250, coming from all over India, from 26 states or territories.

Dr. Viraktamath led off the presentations with a summary of DRR evaluations of SRI, noting that the rice sector in India faces a declining resource base in terms of land, water and labor, deteriorating soil health, increasing environmental concerns, and increasing costs of production. http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala01_Viraktamath_DRR.ppt. [*Note: URLs for powerpoint presentations will be posted on the internet; this report summarizes what appeared to be the most significant data and conclusions from the reports.*]

Water availability per capita in India fell by more than half from 1955 to 1990 (from 5,300 m^3 to 2,500 m^3) with further decline projected to 1,500 m^3 by 2025, declining by 72% within 70 years. Since agriculture consumes about 80% of India's fresh water, and over 50% of this is for rice production, finding water-saving methods for growing rice is becoming more and more urgent.

When DRR began its multi-location trials of SRI in rabi season 2003, SRI yields averaged 16.6% higher than controls. Viraktamath acknowledged that questions have been raised about the representativeness of on-station vs. on-farm results. DRR trials clearly showed that use of young

seedlings was beneficial. When young seedlings were used, high-yielding varieties giving 5-17% more yield, and hybrids gave 46-48% more yield. Multi-locational trials in kharif season the next year showed SRI yield increases ranging from 7 to 42%, and averaging 12%. In 2005, the range was 5 to 69%, with an average of 25%. It was seen that SRI methods were more successful on acid soils than alkaline soils, Viraktamath said. In 2006, the average difference was 11%.

Viraktamath stressed that ***yield is only one criterion*** for comparing SRI with conventional cultivation practices. ***Water use with SRI was measured to average 29% less.*** Also, with SRI there is less pest damage. The larger size of SRI plant roots he showed in pictures, and several bar graphs showed the greater root dry mass and greater root length density measured with SRI practices. These differences, he suggested, probably account for some or much of the impact that SRI methods have on plant health and productivity. The biggest challenges that he identified for farmer use of SRI are: managing soil moisture effectively, and keeping SRI fields weed-free.

In conclusion, Viraktamath noted that SRI practice has proved "significantly superior" to conventional methods in a majority of locations where evaluations were carried out (on-station). However, these evaluations have also showed that SRI methods do not perform well in all locations, so location-specific recommendations are needed. The research thrusts that he listed were: evaluations of different varietal responses to SRI methods; determining the most suitable areas/zones for SRI practice; quantification of water saving; weed management and improvement of weeding implements; detailed studies on soil health and microbial activity; assessment of SRI impacts on pests and diseases; and detailed economic evaluations.

The next presentation was on 'Individual and Combined Effects of Management Components of SRI on the Productivity of Irrigated Rice' by **Dr. Raj Rajendran** and colleagues from the Tamil Nadu Rice Research Institute at Aduthurai plus Dr. V. Subramanaiam from IRRI (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala02_Rajendran_TNAU_ModifiedSRI.ppt). They compared a 'modified SRI' with conventional practice, but it was practically the same as 'usual' SRI: 15-day-old seedlings were planted singly, in a square pattern 22.5 cm x 22.5 cm, with water control maintained; 2 mechanical weedings and 1 hand weeding were done, and a combination of organic and chemical fertilizers was applied. (The SRI recommendation that as much organic matter should be applied as possible has been interpreted by some as meaning that SRI is always or only 'organic.' While factorial trials have shown organic fertilization to be best SRI practice, this is not always practical; in such cases chemical fertilizer can be used with the other methods.) In the trials at Aduthurai and Thanjavur, Rajendran reported that their SRI methods enhanced yield by 29% and 46% in the two locations respectively.

One interesting table in Rajendran's presentation assessed the impact of SRI on **pest incidence**. A right-hand column is added to the table to show the percentage changes recorded.

Pest evaluated	No. of valid seasons	Conventional methods	SRI Methods	**% Difference**
Whorl maggot (% LD)	5	11.56	4.82	**-58%**
Leaf folder (% LD)	8	12.97	21.04	**+62%**
Gall midge (% DT)	2	4.52	2.72	**-40%**

BPH (no. per hill)	4	7.52	1.84	**-76%**
Stem borer (% DT)	6	9.86	5.48	**-43%**
Crop yield (tons/ha)	8	5.127	6.986	**+36%**

Another table showed the impact of different management practices on the **ratio of chlorophyll *a* to chlorophyll *b***, showing some differences in response of two different rice varieties. The difference in chlorophyll *a : b* ratio between (1) conventional + flooding, and (4) SRI + intermittent irrigation was significant with both varieties.

	Chlorophyll *a:b* ratio	
Management system	*Variety ADT 43*	*Variety ADT RA1*
(1) Conventional + flooding	1.27 : 1	1.21 : 1
(2) Conventional + intermittent irrigation	1.33 : 1	1.43 : 1
(3) SRI + flooding	1.52 : 1	1.34 : 1
(4) SRI + intermittent irrigation	1.56 : 1	1.59 : 1

Similar data from the kharif season 2006 were shown for **root growth**, comparing two varieties. While these trials did not show significant varietal differences as was seen for chlorophyll impacts. SRI with intermittent irrigation did show a large effect (28-47%) on root volume:

	Root length (cm)		Root volume (cc)	
Management system *Varieties*	*ADT 43*	*PHB 71*	*ADT 43*	*PHB 71*
(1) Conventional + flooding	11.6	12.0	21.8	19.3
(2) Conventional + intermittent irrigation	15.2	15.1	23.3	26.3
(3) SRI + flooding	16.3	16.1	37.7	39.2
(4) SRI + intermittent irrigation	16.5	16.5	51.0	57.7

Nutrient uptake, evaluated at the TRRI farm in the Cauvery delta in kharif season 2005, showed the following consistent differences that made SRI management more productive:

Management system	Grain (kg/ha)			Straw (kg/ha)		
	N	P	K	N	P	K
Conventional	57.0	7.9	8.7	32.6	5.9	68.7
SRI	**74.1**	**11.0**	**11.3**	**43.7**	**7.8**	**87.0**
C.D. (5%)	4.4	0.7	1.5	4.2	1.3	10.4

Trials specifically evaluating the **effect of seedling age** showed that, other things being equal, the use of older seedlings reduced yield by 23% and 18% at the two locations, respectively. Benefits were also reported from using a mat nursery with young seedlings (15 days) vs. traditional nursery management with older seedlings (25 days). Flooding paddies reduced yield by 17% and 16% at the two locations, other things being equal. A calculation of **synergistic effects** showed SRI practices enhancing yield by 51% and 46% respectively at the two locations.

Finally, a number of calculations of **resource efficiency** were presented, calculated from trial results at the two locations. These statistics, summarized below, indicate the beneficial impacts of SRI methodology in terms that are more important and more meaningful than comparisons

simply of yield. Some data were also presented on the enhancement of grain quality with SRI methods, but these showed slightly larger SRI grain size, which not all consumers consider to be preferable.

	Conventional	SRI	**SRI Advantage**
Nursery cost efficiency (Rs./kg grain)	0.64	0.21	**2/3 less cost**
Water use efficiency (kg grain/m^3 water)	0.33	0.72	**2x more efficiency**
Fertilizer cost efficiency (Rs./kg grain)	0.97	0.61	**1/3 less cost**
Weeding cost efficiency (Rs./kg grain)	0.30	0.20	**1/3 less cost**

Parcha Kishan Rao spoke next as an SRI practitioner, addressing the question whether SRI is in conflict with 'conventional wisdom' (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala03_Kishan_Rao_ConventionalWisdom.ppt). He is an educated farmer who works closely with the NGO WASSAN and who has introduced SRI to farmers in Afghanistan with support from Aga Khan Foundation (http://ciifad.cornell.edu/sri/countries/afghanistan/afgAKFrpt 0707.pdf). Kishan Rao cited work done in India over 70 years ago that underscored the benefits from farming with essentially organic methods (Howard, *An Agricultural Testament*, Oxford University Press, 1940). He also commented on research that showed the benefits of minimizing tillage in order to conserve soil structure and soil nitrogen.

Kishan Rao showed many connections between SRI recommendations and earlier practices, now at variance with scientific recommendations that favor reliance on chemical inputs. He cited a recent paper by IRRI scientists that endorsed the use of young seedlings, and a book by Fukuoka (*One Straw Revolution*) that advocated no standing water in rice paddies, both to get higher yield and to reduce pest and disease attacks.

The final presentation of the Pre-Inaugural Session was by **Dr. M.C. Diwakar** based on DRD evaluations: 'Status of SRI Cultivation and Its Future Prospects in India' (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala04_Diwakar_DRD.ppt). He began by showing how both rice cultivated area and rice production in the current 10th Development Plan period are lower than in the preceding 9th Plan, by 5% and 2%, respectively. The list of SRI benefits that Diwakar enumerated included: 65-70% lower seed requirement; 35-45% less water needed; more tillers/plant and more grains/panicle; uniform maturity; earlier maturity by 5-20 days; healthier plants resistant to major pests and diseases; higher milled rice recovery rate; and SRI yields that are 50-100% more than with conventional methods. (Diwakar's putting yield last usefully put emphasis on considerations that have unfortunately received less consideration.)

Diwakar discussed the need for "a paradigm shift," noting that the Green Revolution strategy is no longer sufficient, and there is need for other strategies. He listed improved crop production technologies, popularization of hybrid rice, and promotion of SRI as appropriate strategies. Trials done under DRD auspices in **Tamil Nadu** in 2004-05 showed SRI methods raising hybrid yields by 20-30%, reaching 10.474 t/ha, while SRI raised yield with HYVs by 15%, to 7.045

t/ha. The economics that Diwakar reported compared SRI use with conventional methods as summarized below. Even with a modest increase in yield (15%), net returns went up by 40%:

	Conventional	SRI
Cost of cultivation (Rs./ha)	20,162	16,737
Yield (tons/ha)	6.0	7.045
Value of production (Rs./ha)	36,000	42,270
Net benefit (Rs./ha)	15,837	25,533
Benefit:cost ratio	1.78 : 1	2.5 : 1

Next, Diwakar reported data on SRI evaluations in **Tripura**, all comparison trials 0.4 ha in area. From 883 trials with nine high-yielding varieties (HYVs), the average increase was **2.5 t/ha**, or 60%, shifting average yield from 4.2 t/ha to 6.7 t/ha. For 97 comparison trials with four hybrid varieties, the average increase was **1.5 t/ha**, or 22.5%, shifting yield from 6.3-6.8 t/ha to 7.8-8.3 t/ha. Local varieties increased yield also by **1.5 t/ha** (60%), raising average yield from 2.5 t/ha to 4.0 t/ha; while local scented varieties, which command a much higher market price, almost doubled their yield with SRI, going from 1.75 t/ha to 3.3 t/ha, an increase of **1.55 t/ha** (89%).

Data from **Andhra Pradesh** collected by the Department of Agriculture from comparison trials (N=30,453) between 2003-04 and 2006-07 showed a **1.78 t/ha** average difference (5.498 t/ha vs. 7.280 t/ha), or 32.4%. Similar data from **Karnataka** state (N=7,588) for three years, 2004-05 to 2006-07, showed a yield differential of **1.31 t/ha** (5.21 t/ha vs. 6.52 t/ha), or 25%. Two years of data from **Tamil Nadu** showed a **1.37 t/ha** yield gain with SRI (5.574 t/ha vs. 6.943 t/ha), also 25%. Less data were available to report from **Punjab** state, but 2006-07 experiments showed an SRI yield (without puddling) of 3.14 t/ha vs. conventional yield (with puddling) of 1.9 t/ha, an increase of **1.24 t/ha** (65%). SRI plots in Punjab had more than doubled number of tillers/m^3 (415 vs. 171), with 13.7% longer panicles and 7.2% more grain weight. Unfilled (chaffy) grains were reduced by 8%, which contributes to more consumable rice produced. Diwakar's last slide showed bar graphs making comparisons across states, consistently favoring SRI. A tea break followed his presentation which concluded the morning's first session.

The **Inaugural Session** began with the lighting of a ceremonial oil lamp, and then as an apparently unplanned part of the program, some farmer-participants came up on the stage to present the guests with large panicles of SRI paddy. A welcome address was given by Tripura's Director of Agriculture, **Dr. S. N. Sen**, and the purpose and objectives of the Symposium were reviewed by **Dr. Gujja** from WWF. Brief remarks followed from **Dr. Viraktamath**, DDR director; **Dr. Ayyangar**, Commissioner and Secretary of Agriculture; **Dr. Shashi Prakash**, Chief Secretary of the Government of Tripura; and myself.

Plenary participants were then invited to witness the 'release' and distribution of six new publications on SRI:

- *More Rice with Less Water: SRI – System of Rice Intensification*, produced and published by the WWF Dialogue Project on Water, Food and Environment, Patancheru, 2007.

- *Farmers Experiences in SRI Cultivation*, edited by L.G. Giri Rao and P. Punna Rao, published with WWF support by Acharya N.G. Ranga Agricultural University, Hyderabad, 2007.
- *Technical Bulletin on System of Rice Intensification – A Water-Saving & Productivity-Enhancing Strategy in Irrigated Rice*, edited by R. Mahender Kumar et al. and published by Directorate of Rice Research/Indian Council for Agric. Research, Hyderabad, 2007.
- *More Rice, Less Water: Small State, Big Results – Experience of SRI in Tripura, India*, published by WWF with Tripura Department of Agriculture, Agartala, 2007.
- *SRI in Tripura: Retrospect and Prospect*, written by Tripura Department of Agriculture and published by WWF for 2nd National SRI Symposium, Agartala, 2007.
- *Towards a Learning Alliance: SRI in Orissa*, written by C. Shambu Prasad, Koen Beumer and Debasis Mohanty and published by WWF and Xavier Institute of Management, Bhubaneswar, 2007.

After this ceremony, the Chief Minister, **Shri Manik Sarkar**, gave the Inaugural Address, and the Minister of Finance, **Shri Badal Choudhury**, gave a Presidential Address. Both expressed appreciation for the improvements in rice productivity and farmer incomes being achieved with SRI and pledged to continue the government's support. The Minister of Finance noted that tribal farmers, who have been very committed to their traditional methods of cultivation, are "very much enthusiastic on SRI cultivation." Baharul Mazumder was called upon to give the Vote of Thanks on behalf of all the participants, and the morning session ended with a flourish.

After lunch, the first session was on **International Experiences on SRI**, which I was asked to chair and to lead off with a review of SRI initiatives and results in the other countries of **Asia**, outside India (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala05_Uphoff_AsiaReview.ppt) Dr. Muazzam Husain reported on 'Some Agroecological and Institutional Aspects of SRI: The **Bangladesh** Case' (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala06_Husain_Bangladesh.ppt). Husain highlighted certain environmental factors that have constrained SRI spread in Bangladesh: many soils are not very good for rice production; rainfall and flooding are significant during the monsoon, so many rice fields are submerged for part of the kharif season; in the winter (rabi/boro) season, when it is more feasible to use SRI methods, cold temperatures are often unfavorable for use of young seedlings.

Husain emphasized that agronomic adaptations need to be made accordingly. Unfortunately, there has been a lack of government support for SRI extension because many researchers at the Bangladesh Rice Research Institute (BRRI) are apathetic or even hostile toward it. Staff and leadership of the Department of Agricultural Extension (DAE) have been more favorably disposed, however DAE has not given sustained or cumulative support. Fortunately, the backing of NGOs for SRI has been building, thanks to support from Oxfam GB and ActionAid, but SRI coverage in the country is still very limited overall. A SRI National Network of Bangladesh was formed this past year based at the Bangladesh Rice Foundation (BRF), a national NGO in Dhaka.

Whenever systematic evaluations have been done, these have given mostly very positive results. The IRRI program in Bangladesh supported a two-year evaluation under its PETRRA project, 2002-2004. This had 1,278 on-farm comparison trials, covering a total area of 120 hectares. Yield gains in the two years ranged from 19 to 37% and 23 to 30%, with farmers' net economic returns increasing 32-82% and 35-73% in the two years. Subsequent evaluations supported by Oxfam GB and ActionAid have documented yield increases of 25-42% and 36-37%. Farmers' perceptions have been quite positive. However, trials have been mostly small-scale and need both to expand in scale and to continue for a longer time to have the desired impact.

Husain concluded that "progress and impact of SRI in Bangladesh have been modest due to various factors mentioned." However, a memo of understanding has been signed recently between BRF and DAE for an expanded government extension SRI effort, and NGO support for SRI is continuing to grow. Also faculty at the Bangladesh Agricultural University are now taking more interest. The formation of the national network has encouraged everyone to anticipate that in the near future they can begin having more significant impact on SRI adoption rates.

Next, Karma Lhendup reported on 'Evaluation of SRI in **Bhutan** (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala07_Lhendup_Bhutan.ppt). This began in 2006 in the eastern part of the country, with three sets of replicated trials between 1600 and 2000 m. Only three of the six SRI practices were systematically evaluated – seedling age, spacing, and water control -- not the whole set of practices. However, the value of all three of these practices was confirmed. Average yields with these practices were 4.8 t/ha compared to 4.13 t/ha in the control plots having older seedlings, closer spacing, and continuous flooding.

National average paddy yield in Bhutan is 2.88 t/ha. The cost and water savings with SRI methods are of interest to farmers who participated in the field days, and there is now interest among researchers, extension workers, and government decision-makers. That Bhutan is now promoting organic production methods as a matter of policy adds to SRI's relevance. (After the Symposium and field visits in Tripura, Marguerite and I spent a week in Bhutan with Karma getting acquainted with farmers and their situations as well as with researchers and policy-makers involved with SRI. Our observations will be written up in a separate report.)

Then, Ngo Tien Dung, director of the National IPM Program in **Vietnam**, gave an account of SRI experience in his country, where evaluations of SRI started in 2003. Rice production in Vietnam is already quite 'intensive' in terms of using external inputs. Overuse of nitrogen and high density of plant populations have contributed to high incidence of pests and diseases. Just by reducing the application of urea by 30%, it has been possible to get 10-15% higher yield. (Another instance of less input giving more output.) Farmers have found that by reducing fertilizer and agrochemical use with SRI methods, they get 1-1.5 t/ha more yield, raising this typically from 5-5.5 t/ha to 6-7 t/ha.

The Ministry of Agriculture and Rural Development has designated SRI as a "technology advance," Dung reported, so more government funding is expected for SRI extension in the coming year. Seventeen provinces are targeted for SRI spread, and Oxfam US is assisting in six of these provinces. A network of government, university and NGO partners is forming to

communicate and cooperate among institutions so that SRI dissemination will become a broader collaborative effort.

Chou Cheythyrith from the National IPM Program in **Cambodia** gave an overview of SRI in his country (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala08_Cheythyrith_Cambodia.ppt). SRI work began there in 1999-2000 through the efforts of CEDAC, a local NGO. Now SRI efforts are supported by the government's Ministry of Agriculture, Forestry and Fisheries (MAFF) in 24 provinces and municipalities, and 32 NGOs are actively involved. This year, over 60,000 households are using SRI methods on 16,385 hectares, according to a recent tabulation. SRI methods are being adapted to a variety of conditions in which either lowland or upland rice is grown.

The rice plant has great natural potential, Chou stressed, which can be brought out through better management practices: 50 tillers per plant, and sometimes many more; larger and deeper root systems; bigger panicles; and higher quality grain, with more milling output. In 2006, when the national average yield at 1.92 t/ha, average SRI yield was **4.7 t/ha**, with reduced input of seeds and fertilizer. Chou's concluding remark was that "SRI is growing very fast in Cambodia."

The last county report was a preliminary assessment of SRI in **Fiji** by **Dr. S. V. Subbiah** of DRR, who is giving technical advice there (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala09_Subbiah_Fiji_DRR.ppt). Rice self-sufficiency in Fiji has fallen from 65% to 20% in recent years, so a big push is being made to raise rice production. Trials comparing SRI with Integrated Crop Management (ICM) -- very similar to SRI but with slightly older seedlings (15-day instead of 10-day) and somewhat closer spacing (20x20 cm instead of 25x25 cm), employing the same water control, weeding and fertilization – showed similar grain yields, although SRI gave 7% more straw yield.

While previously serving as acting director of DRR, Subbiah oversaw extensive evaluation of SRI under the All-India Coordinated Rice Improvement Program in 2004-05. So he reported briefly also on these results, which showed an average 28% yield advantage for SRI, using 70% less seed and 30% less water. Subbiah also discussed other innovations: the use of improved genotypes, including hybrids; use of a drum seeder for direct-seeding to save labor; and incorporation of integrated pest management (IPM) methods to SRI practice, all good ideas.

In his summary comments as co-chair for the session, Dr. Diwakar from DRD, highlighted the advantages of a 'community approach' in the spread of SRI, i.e., doing demonstrations on a group basis, and seeking to overcome any reservations through group discussion and evaluation. He said that participatory action research is becoming more common and has a lot to contribute to agricultural development.

Since all the sessions had run over time and we were far behind schedule, the tea break was sacrificed, and the next session on **Experiences on SRI Promotion/Adoption** began without a break, with **Dr. R. A. Sherasiya**, Director of Agriculture for Gujerat state in the chair. Although rice is not a major crop in his state, he said, it has 70,000 ha under rice, and soil health is

becoming a major issue for farmers in Gujerat. He described a 'soil health card' being distributed to farmers there that could be a very good complement to SRI introduction.

Dr. L.G. Giri Rao, Director of Extension for ANGRAU, led off with a presentation on 'SRI Promotion and Adoption: Field Experiences across the Country.' (I didn't get his powerpoint.) He reviewed data from over 30,000 trials in Andhra Pradesh, which showed an average SRI yield increase of 25% (range 21-30%), with cost reductions averaging 11% (range 6-19%), raising incomes on average by 28% (range 27-32%). (Unfortunately, these numbers do not parse, since a farmer with a 1.5:1 revenue:cost ratio who gets 25% more revenue from increased production while lowering his costs of production by 11% will find that his net income is almost doubled.) Giri Rao reported that with SRI methods, farmers are able to harvest their rice crop about 10 days earlier, and they have fewer pest and disease problems. His presentation was followed by state-by-state reports.

The next report was given by Murari Chowdhary on 'The System of Rice Intensification in **Jharkhand and Bihar**: Bringing New Perspectives to the Search for Household Food Security' (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala10_JharkhandBihar_Bihar.ppt). Chowdhary is director of an NGO known as NEEDS, working in impoverished communities in these two states. Its work has support from the Sir Dorabji Tata Trust (SDTT) for programs in 41 villages in Jharkhand and 16 villages in Bihar, with 1030 families using SRI methods on 430 hectares. SRI yields in these communities were reported to have ranged between **6.2 and 12.9 t/ha**. Chowdhury's powerpoint included some dramatic pictures of SRI fields and plants and smiling farmers.

Two case studies were presented. One gave components-of-yield details from the farmer who had reached 12.9 t/ha, and the other was on a farmer who with SRI methods had increased his yield from 3.45 to 9.25 t/ha. In 2005, 53 families assisted by NEEDS who had previously produced only enough rice to meet 5-7 months of their home consumption needs were able to harvest **enough rice for 14-18 months of consumption**. This means they now had a surplus to raise household incomes, whereas before they had to hire out their labor or migrate to another region to be able to ensure their food security throughout the year. Chowdhary emphasized the importance of doing frequent weedings to get best results with SRI. This was resisted at first, he said, but the visible improvements in yield and income have made weeding, plus use of green manures, popular among farmers. Local varieties have shown outstanding results, he also noted, so they are more popular than HYVs.

[Note: Such results are not unique to NEEDS experience in the eastern Gangetic Plains. Similar results have been obtained by farmers in Jharkhand and Bihar, as well as in Orissa, Madhya Pradesh and West Bengal states who work with PRADAN, an NGO introducing rainfed SRI in poverty-constrained villages. The Bihar state government has recently provided PRADAN with funding to extend its SRI work to 25,000 households, appreciating PRADAN's success with 6,500 households who have obtained average rainfed SRI yields over 7 t/ha, compared to their previous yields of 2-3 t/ha.]

Then, Dr. Ayyangar reported on 'SRI Experiences in **Tripura**' (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala11_Tripura_Ayyangar_DOA.ppt). He said that the state government had been stymied in its efforts to move toward self-sufficiency in rice because yields in Tripura had been "hovering" around 2.5 t/ha. They needed to reach at least 3 t/ha to meet their goal. "We were groping in the dark," he said frankly. Then in 2005, Baharul Majumder "dragged me to farmers' fields to see SRI. I could not believe what I was seeing. How could rice grow without standing water? I wondered… A belief in the need to flood rice was ingrained in my brain, and it took some time for me to remove this mental block." However, he said, the demonstrated results are ones that can enable Tripura to achieve its goal of self-sufficiency.

Extension strategy in Tripura has emphasized farmer training and cross-visits, working with and through local government (Panchayati Raj) institutions at all levels. The government is also encouraging use of agricultural implements to reduce labor requirements. The average increase in yield with SRI methods has been about 2 t/ha, across most varieties and in most areas of the state. "If farmers do not achieve this increase, they are not getting the message and doing SRI correctly." In 2005-06, the government's SRI target was 16,000 ha, and they achieved 14,876 ha with more than 74,000 farmers using SRI methods. This is a huge increase from the 880 farmers practicing SRI just two years before. The Secretary expressed his satisfaction with SRI and said that his government will be glad to share their experience with any other states in India.

Debashish Sen next reported on 'Promoting System of Rice Intensification (SRI) among Marginal Farmers in **Uttarakhand and Himachal Pradesh**' (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala12_UttarakhandHPSI.ppt). Sen is director of the Centre for Participatory Watershed Development which operates under the aegis of the People's Science Institute (PSI) based in Dehradun. PSI has had support from the Sir Ratan Tata Trust, and also technical assistance from WASSAN, for its work with poor households in the Himalayan region. Sen presented data from 40 farmers with whom PSI is working in 25 villages, having 0.4 ha average landholdings. So far they are putting only a small part of their rice land under SRI, to gain experience and confidence. But the results have been very encouraging.

Sen presented detailed data on two farmers who used all of the methods as recommended and who saw their rice yields go, respectively, from 3 to 7.5 t/ha and from 4 to 7 t/ha. Two others who planted a Basmati variety had their yields go from 2.5 to 3.9 t/ha and 3.8 to 6.5 t/ha. The latter farmer used the improved variety Pusa Sugandh, which responded well to SRI methods.

The pooled results for all 40 farmers in both states showed a 66% increase, from about 3 t/ha to 5.0-5.5 t/ha. An adaptation of SRI methods to conventional broadcast rice raised the benefit:cost ratio from 1.2:1 to 1.5:1, while with transplanting, the B:C ratio was raised from 1.9:1 to 2.4:1 with SRI. Using SRI methods with transplanted Basmati (variety Type-3), the B:C ratio was further raised from 2.6:1 to 5:1, making this alternative very attractive economically.

Of interest scientifically and practically were the comparison trials that Sen reported on PSI assessments of the effects of **seedling age** and **frequency of weedings** (quintals/ha are converted

into tons/ha below). Note that at higher elevations, seedling growth is slower due to the colder temperatures, so this means that somewhat older seedlings are biologically the same age as 'younger' seedlings at lower elevations. Possibly there was some interaction effect between the two variables, but the results are consistent with what has been found with carefully controlled and replicated trials.

Age of seedlings (t/ha yield)		Number of weedings (t/ha yield)	
>23 days	4.0-4.5	One	5.0-5.5
16-23 days	5.5-6.0	Two	6.0-6.5
10-15 days	7.0-7.5	Three	7.0-7.5

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Of further interest agronomically were the results reports from PSI's experiments applying SRI concepts and practices to **wheat**. Two varieties were used, comparing conventional broadcasting crop establishment with adapted SRI methods: direct-seeding but wider spacing between plants and hills, more use of organic fertilization, and active soil aeration by weeding. Grain yield with conventional methods was 1.4-1.8 t/ha, and with adapted SRI methods, 2.0-2.5 t/ha.

In Himalayan regions, straw yield is important because cattle fodder has value. With usual methods, this was 6.4-7.2 t/ha and with SRI it was 7.2-8.5 t/ha. [A special posting will be made on 'SWI' on the SRI home page] The initial adaptation of SRI to wheat production, Sen said, is still too labor-intensive for widespread adoption. But PSI staff are working with farmers to reduce labor requirements for wheat crop establishment and management. PSI is now also evaluating extrapolations of SRI practices to **finger millets** and **pulses** on 100 mountain farms, paying attention to fodder production as well as to the amount of grain produced.

Regarding SRI, Sen said that farmers see the following advantages: less seed requirement, saving in water, decreased workload, promoting equity, early maturity, higher grain yields (note that yield was listed 6th), increased biomass, and improved soil fertility. The constraints identified included: time-bound operations, labor-intensity, limited access to weeders and markers, need design modifications in the current weeder design for use on small terraces, and availability of water under rainfed conditions, especially after milking stage.

Sen said that after seeing the first year's results, there is a lot of demand from farmers for SRI instruction. Six hundred farmers have taken up SRI already, 15 times the initial 40, and 1,000 farmers have registered for the 30 workshops that PSI will be conducting with NABARD support. In conclusion, Sen characterized SRI as "a boon to mountain farmers," saying that SRI can address effectively the food security and livelihood needs of small and marginal farmers.

Pparticipants' attention was redirected from the far north of India back to the south with a presentation by **D. Rushendranath** from the AP Department of Agriculture on 'SRI Experience in **Andhra Pradesh**.' [URL] He began by listing reasons why there is 'Need for SRI': depletion of water resources, stagnation of rice productivity, growing importance of organic agriculture, increasing production costs, and need for best utilization of family labor for small and marginal farmers. Echoing the benefits of SRI that others had already noted, he listed:

1. Higher yields – of both grain and straw
2. Reduced duration of crop cycle (by 10-15 days)
3. Less chemical inputs
4. Less water requirement
5. Less chaffy grain (%)
6. Grain weight is increased without change in grain size
7. Higher head rice recovery rate
8. Can withstand cyclonic gales
9. Soil health is improved through biological activity

The AP state government has approved an Action Plan for 2007-08 allocating Rs. 91.945 lakh, about $240,000, to SRI promotion, he said. The main constraints identified were that current designs of markers and weeders are not always the most suitable for certain kinds of soil, and there are difficulties in doing weeding with the present weeders; there are operational difficulties in adopting SRI methods on large areas; and there are no clear recommendations on how much reduction should be made in water applications.

About half of the suggestions listed for scaling-up SRI were for different kinds of subsidies -- for weeders and markers, puddlers and levelers, sprayers, vermicompost, green-manure seeds, etc. This suggesting stereotyped thinking from the Department side, implying that farmers (unlike in Tripura) do not find SRI methods advantageous and thus need to be compensated for making the recommended changes in practice. The extent to which SRI dissemination should or must rely on subsidies is an unresolved question. Some of the other suggestions were obviously reasonable: for varietal trials, for research on water-saving options, and for better weeder design, as well as for field trips and exposure visits for farmers, and intensive training in SRI methods for laborers.

Dr. S. K. Sinha, Director of Agriculture for the State of Sikkim, as co-chair for the session gave a summary of the presentations, noting that his state, which recently declared itself an organic state, should begin systematic trials of SRI at once. Unfortunately, there was no enough time in the three-day schedule to have plenary reports from all of the states. I should mention one presented in the next day's technical sessions as part of the field trips, not in this plenary session. **Dr. Amrik Singh**, Agricultural Development Officer in the Punjab Department of Agriculture and Deputy Project Director for ATMA, an extension reform program, gave a very impressive powerpoint presentation on 'SRI Experience in **Punjab**.'

Singh conveyhed a sense of urgency by pointing out the imminent danger of 'desertification' in Punjab due to the over-extraction of groundwater there. Over half of the districts in the state are classified as 'over-developed' agriculturally because they are pumping so much water to irrigate their crops that the water table is falling rapidly. Already at the 1st SRI Symposium, Singh had reported that over the past 30 years, the water table in Punjab has fallen from 30 to 70 feet; at present rates of extraction, it will fall further to 160 feet by 2023, making continuing irrigation uneconomic and even technically infeasible.

Singh's list of reasons explaining 'Need for SRI' was headed by Depletion of underground water table, followed by: Degrading soil fertility; Shrinkage in average size of landholding; Rise in

farmers' cost of cultivation; Micronutrient deficiencies in soil; Development of pest resistance; and Decrease in production and productivity. In Punjab, the agricultural sector's rate of growth has been falling rapidly: from 4.7% in 1992-97 to 2.1% in 1997-2002, and now 1.5% in the 2002-06 period. The state government projects a restored rate of growth of 4.2% for the next five years, but without explaining how it will reverse the negative trend of the past 15 years.

Singh's presentation was supported by many pictures, including of a farmer presenting SRI panicles to the state's Minister of Agriculture. The economic assessment of SRI was somewhat different from others' in that it showed some increase in the costs of production – from Rs. 6,482/ha with conventional methods to Rs. 7,943/ha with SRI. (SRI methods as used in Punjab so far are fairly labor-intensive). Even so, given the greater production and higher resulting revenue – which goes from Rs. 21,465/ha to Rs. 33,615/ha -- farmers' net income from SRI goes up by more than two-thirds, rising from Rs. 14,981/ha to Rs. 25,682/ha. ***This is achieved with a 45-50% reduction in water use.*** Singh reported that over the past three years the number of farmers cooperating with his program introducing SRI has gone from 10 to 25 to 150, with area rising from 3 to 30 to 175 hectares.

The benefits from SRI that have been observed by farmers include:

- 75% less seed
- 45-50% less water
- 25-40% less fertilizer
- Uniform maturity, and 8-10 days shorter crop cycle (time to maturity)
- 25-40% more yield
- Strong and profuse rooting and tillering, with resistance to lodging
- Pest and disease resistance, especially for foot rot in Basmati rice
- Soil health with increased biological activity

The suggestions that farmers have made for improving SRI application in their state were:

- More use of green manures and compost, and good land preparation
- Draining of fields before transplanting, to get thicker mud
- Experimentation with different planting distances (to find optimum)
- Need for motorized mechanical weeding
- Research on chemical weed control for where there are labor shortages

The constraints that farmers identified for SRI adoption were first of all: Psychology and attitudes. Then: Transplanting difficulties; Water control and management; Lack of implements (weeders and markers); Sometimes conoweeders are not working (this complaint about inappropriate design, or poor quality of manufacture, has been voiced often); Non-availability of organic manures (something that can be remedied); and Labor-intensity (being addressed through innovations like direct-seeding). Singh's presentation ended with a number of suggestions, all reasonable, with little emphasis on subsidies.

There was also in that session (Group I) a report from the private sector in **Haryana** state: 'SRI in Basmati: A Win-Win Situation for Farmers and Rice Processors,' from **Anurag Tewari**, a manager in Tilde Ricelands Pvt. Ltd. in Kurukshetra

(http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala15_Haryana_TildaLtd_Basmati%20SRI.ppt). This company is the largest Indian processor and exporter of Basmati rice, and it is now promoting SRI with farmers. Research conducted in kharif seasons of 2004 and 2005 by the Tilde Ricelands' agri-research wing, called FOSTER (Field of Systematic Trials and Experiments on Rice) has confirmed that with SRI methods, there is higher yield, improved grain quality, and greater economic competitiveness. Tewari reported also reduction in lodging, in incidence of blast disease, and in percent of broken and immature grains. Such considerations have led Tilde to give private-sector support to SRI extension.

Before the first day's deliberations concluded, **Dr. V. Ravindra Babu** (DRR) made a report on the posters that had been on display during the day, 15 in all: 6 from Andhra Pradesh, 3 from Chhattisgarh, 2 each from Bihar and Karnataka, and 1 each from Jammu & Kashmir and Bangladesh. Most frequent themes were: assessment of crop responses to different cultivation methods; experience with pests and diseases; and impacts on microbial populations. Several reported that labor shortages are slowing the spread of SRI despite very good agronomic results. Many reported lower pest and disease incidence in SRI plots. Much valuable scientific and practical information was contained in the set of posters, but I was not able to spend any time with them. It is hoped that the Symposium organizers can post these, if possible, on the internet. A musical program presented to participants before dinner, with top singers and musicians from Tripura performing, meant that dinner was finished well after 9, making this a 12-hour day.

October 4 – Thursday

The second day of the Symposium was spent in field trips that enabled participants to see how SRI methods are spreading in Tripura, and with what effect. Participants were able to interact with farmers and among themselves to assess SRI experience and results. Organizing field trips for over 250 persons is a mammoth task under the best of circumstances, and the logistics of getting so many people to dispersed rural villages are daunting. Organizers of the symposium were able to contemplate and then accomplish such a feat only because the staff and vehicles of the state's Department of Agriculture were fully mobilized to support this program.

Marguerite and I were assigned to the third of four groups so that we could see how SRI was being adopted in some of most 'difficult' villages in Tripura. Our group was composed of 58 persons from 16 states of India, plus participants from Bangladesh, Bhutan and Vietnam, who traveled 45 km northeast from Agartala to visit **Teliamura Subdistrict**, a part of West Tripura district that has significant tribal and low-caste populations.

The group was first ferried in buses for an hour and a half to get to Teliamura town, where we then regrouped in minivans to travel another half hour to reach the first village, which buses could not take us to. At each location, handouts were passed out that gave us data on the village being visited and on its SRI experience. The main descriptive information is summarized below:

Village name	North Maharanipur	Maiganga	East Howaibari
Area of village (ha)	382	508	436
Cultivable area (ha)	172	343	135
Cropping intensity	200%	250%	250%
Assured irrigation (ha)	75	70	30

Population	1800	3648	1832
% Scheduled tribes (or scheduled castes)	99%	70%	20% (40%)
No. of cultivators	532	822	270
Cultivators' status	100% small farmers	90% small farmers, 10% marginal farmers	60% small farmers, 40% marginal farmers
Area under paddy (ha)	180	248	85
Area under SRI (ha)	100	100	54
No. of SRI farmers	143	200	92

The SRI results reported by Dept. of Agriculture staff are summarized below. The average SRI yield increase for farmers in the three villages over three seasons was 2.23 t/ha -- or 60%.

Village and season	Non-SRI Yield (t/ha)	SRI Yield (t/ha)
N. Maharanipur		
Rabi 2006-2007	4.50	6.95
1st kharif 2007	2.875	5.75
2nd kharif 2006	3.5	6.26
Maiganga		
Rabi 2006-2007	4.3	6.95
1st kharif 2007	2.97	5.6
2nd kharif 2006	4.5	5.95
E. Howaibari		
Rabi 2006-2007	4.39	6.85
1st kharif 2007	3.0	5.4
2nd kharif 2006	4.5	5.6
Average across all seasons	3.83	6.16

En route to Teliamura, we could see from the road in many places triangular yellow flags flying over individual paddy fields. These indicated that the farmer managing this field was using SRI methods. Many areas had no flags as only 8% of the state's paddy area is presently managed this way. However, in some areas that we passed, the flags were not only evident but numerous.

When we reached the village of North Maharanipur, the last stretch of the road was lined with yellow SRI flags, and on a large tract of paddy land above the village we saw yellow flags on practically every field. The Department official guiding our group said that in this village, one of the most remote in the subdistrict, 100 hectares of rice are being cultivated with SRI methods by 143 farmers.

This village's population is composed entirely of small-farm tribal households who have taken enthusiastically to SRI. They are getting 70% higher yields on average and also other benefits that they enumerated for us once we were seated under a large awning pitched on an uncultivated area adjoining their fields. Some SRI fields we passed had standing water on them, but it was explained that there had been heavy rains yesterday and not all the water had drained out. All the fields had small ditches dug every 8 feet across their breadth to facilitate shedding excess water.

Farmers confirmed that they now use seedlings only 10-12 days old (maximum 14 days) with 25x25 cm spacing. Before they used to transplant 30- or 35- day seedlings much more densely. In many fields, we saw delicate rice plants growing with narrow leaves. This is a local variety – *Kalikasa* -- that is much appreciated for its taste and aroma. Normally it gives about 1 t/ha yield, but the high price that it commands makes it very profitable. With SRI methods, it gives 2-3 t/ha. An extension agent with us said that with SRI, *Kalikasa* gives "bolder seeds," i.e., larger grains. We saw another scented variety, *Biran*, also being grown with SRI methods. Both local varieties, being spindly, are susceptible to lodging, but this problem is largely eliminated when SRI cultivation practices are used, we were told.

We passed many plots of the modern variety MTU-7029, known popularly as *Swarna*, developed at Maruteru Rice Research Station in Andhra Pradesh. It has been considered 'shy-tillering,' but with SRI methods, it tillers profusely. Swarna is now widely grown throughout the northeastern region of India because it can produce well with low amounts of nitrogen application. Its fields can be identified from a distance by their dark green color. In Tripura, we were told, *Swarna* is giving doubled yields with SRI methods.

Rice plants that have higher chlorophyll content and produce more grain must be getting large amounts of nitrogen from biological sources if their soil is not getting exogenous amendments of fertilizer. It appears that *Swarna* is benefiting from -- and maybe even stimulating and supporting -- greater soil biological activity. This variety, we were told, is relatively resistant to sheath blight when grown with SRI methods. The *Swarna* plants that we saw had 30-35 tillers at 42 days after transplanting.

In our discussion with farmers, the average SRI yield in the previous rabi (winter) season was reported to be almost 7 t/ha, compared with 4.5 t/ha using conventional methods. Farmers said that the extension worker who lives in this village was in the fields with them from 5 or 6 o'clock every morning during the whole season, helping them learn and use the new methods.

At first SRI was difficult, farmers said, because it required more time. But now they are able to do SRI transplanting "very rapidly." The mechanical weeders provided through the Department enable farmers to reduce their weeding time by about 50%. I was struck by how widely varying are farmer assessments of mechanical hand weeding recommended with SRI. Some farmers consider using the weeders as terrible drudgery, while others find the implements beneficial, even liberating. Here the view of SRI weeding strategy was very positive.

Overall, SRI has become labor-saving, farmers said, which they appreciate along with its enabling them to save seed. They also save water and use less chemical fertilizer, reducing their urea application rate from 25 kg/ha to about 10 kg/ha. They apply more organic matter, 7-8 t/ha of farmyard manure. Some P and K are also applied, they said. Most farmers also use a combination of N-fixing Azotobacter and phosophorus-solubilizing bacteria (PSB) as biofertilizer, at a rate of about 4.5 kg/ha. They commented that their SRI rice crop is "less chaffy," with fewer unfilled grains, and that the grains that SRI produces are "bolder."

Several members of our group who remained skeptical about SRI being as good as reported tried to elicit some adverse comments from the farmers. But the farmers, while acknowledging some initial difficulties in learning the techniques, were firm in their positive assessment. Asked about water management, they stressed the importance of putting in drains across their fields, every 8 rows. They apply water every 8-10 days, taking turns, and getting about 16 hours of supply in a turn. If fields are kept inundated, they said, "the tillers are less." They acknowledged that they do not know exactly how much water is being saved with SRI, because they have no means to measure volume. But water use is "very much less," farmers insisted.

The last question was whether farmers here will continue to use SRI methods if the government subsidy given now to encourage its adoption is withdrawn. The farmer who had been speaking most often on behalf of the community, **Chandra Dev Verma**, said without hesitation, "I will continue without assistance." No vote was taken, but this appeared to be community consensus.

The next village visited, **Maiganga**, was a 'seed village' where most farmers are following quality-control standards set by the Department for producing seed paddy. Here, 200 farmers out of 822 (not all cultivating paddy) are using SRI methods on 100 hectares of their 248 ha of rice area. Households here are mostly low-caste rather than tribal, but their experience and answers were similar to those in North Maharanipur. Their rabi-season SRI yield was 6.95 t/ha, compared with 4.3 t/ha when using conventional methods.

When asked what were their main problems for adopting SRI, the two farmers who spoke for the community said: "At first, we were afraid that single seedlings would not succeed." Are there still concerns about this? "Not any more." They have used SRI methods in this village for six consecutive seasons. "Now everybody uses," it was said. This is an overstatement, since not all the rice area is under SRI, but apparently most farmers are using it on at least some of their land.

Farmers were asked about costs of cultivation. Traditionally, the cost per kani (1/6 ha) is 1500 rupees. With SRI, their costs are 200-300 rupees less per kani, a reduction of 15-20%. With their yield increased by more than 50% (the handout showed a 62% increase in rabi season, and 88% more yield in kharif), they said that they are getting more than 12,000 rupees (over $300) more income per hectare. It is no wonder that satisfaction was expressed.

The field trip was by now far behind schedule, and past the time scheduled for lunch, but a third visit was made as planned (with lunch deferred) to **East Howaibari** village, because we were told that the farmers there were keen to have us see their SRI plots. The farmers in this village are mostly tribal or low-caste, and all ware small or marginal farmers. Of their 85 hectares of paddy land, 54 hectares are under SRI, cultivated by 92 farmers, averaging just 0.6 ha each.

Several farmers were weeding their paddies with rotary hoes when we arrived, but in a laborious way, pushing the weeder forward and then pulling it back as they advanced down the rows. Kishan Rao, a farmer from Andhra Pradesh who has done SRI training in Himachal Pradesh, Afghanistan and other places, removed his sandals and got into the paddy field, flooded to make weeding easier, to demonstrate a faster and less energy-consuming way to use the weeder, which

everyone appreciated. We agreed that a better cono-weeder design should be tried on these heavy clay soils, a design easier to use and yet sufficiently able to control weeds and aerate the soil.

We were impressed with the careful and effective management of the SRI crops here and were given coconuts to drink and refresh ourselves as we left the village. From there, the group moved in minivans to a large local hotel for lunch, and then to the local government center for a late afternoon session with four presentations by Symposium participants. Each of the four field trip groups had a similar session for technical presentations. Presenting all of the papers/reports in plenary sessions would have required lengthening the Symposium by an additional day.

While people were getting settled for the session, a video was shown on SRI techniques. One ingenious method caught my attention -- for marking lines on a muddy paddy field to facilitate transplanting in a square pattern. A long elastic or rubber rope is stretched across the field, 25 cm from and parallel to a 'line' previously 'drawn.' Someone lifts the middle of the rope to shoulder height and then snaps it back onto the mud, creating a distinct and straight line the full length (or width) of the field. The rope is then moved another 25 cm to make another parallel line in the mud. This rope-snapping process can save farmers a lot of time for marking their fields, even compared to the roller-marker, which was an advance upon the wooden rake for marking a grid pattern on the field, which in turn was an advance upon the initial method using sticks and string.

The first paper compared the impact on rice plants, when using SRI vs. conventional practices, of certain **growth-promoting microbes**: Azospirillum, a bacterium, and Trichoderma, a fungus. This was presented by **Ravi P. Singh** from Benares Hindu University in Varanasi. Singh offered considerable and consistent data that could be explained by the more favorable plant growth conditions that SRI creates which also favor the growth of soil organisms.

With the same levels of nitrogen application, Singh showed the following differences:

	Traditional methods	SRI methods	SRI methods + biofertilizer
Plant height (cm)	108.5	112.2	114.4
Dry biomass (kg/q)	512.2	561.2	579.5
Dry root biomass (kg/q)	223.0	236.0	235.0
Yield (tons/ha)	5.56	5.9	5.87

These data showed that in these trials, although biofertilizers had an impact on above-ground growth, they did not appear to affect the roots or yield much or at all. They did have a beneficial impact, however, by reducing several major rice-crop diseases. The average differences shown below were observed, evaluating four different rice varieties and scoring disease severity on a 0-9 scale. Singh said that insect pests were also observed to be lower with SRI and especially when biofertilizer was used; however pests had not been counted, so no differences could be reported.

	Conventional methods		SRI methods	
	Without biofert.	With biofert.	Without biofert.	With biofert.
Bact. leaf blight	6.6	2.5	5.0	1.5

Leaf blast	4.0	2.0	3.5	1.0
Brown spot	5.75	1.25	5.25	1.5

Trichoderma and Azospirillum are two of the several organisms known to promote plant growth that are being produced by the Tripura Department of Agriculture and sold to farmers, as I learned from farmers during this and subsequent field visits. Numerous bacteria and fungi are able to fix nitrogen; solubilize phosphorus and other nutrients; give plant roots access to larger volumes of soil for uptake of water, phosphorus and other inputs (mycorrhizal fungi); produce phytohormones that promote and regulate plant growth (many aerobic bacteria and fungi); compete with and constrain soil pathogens; and/or confer systemic resistance (ISR) to pests and diseases. This is an area of research and practice that is starting to expand rapidly, and it is not limited to SRI. It was encouraging to see the connections being examined for SRI by Singh, and maybe others.

Dr. L.V. Subba Rao from DRR next presented a paper on how SRI methods can contribute to **quality seed production**. He had evaluated two modern varieties with three methods, including SRI, and concluded that SRI enables growers to increase their productivity when growing seed stock. With SRI management, the number of days to 50% flowering was reduced from 85.6 to 77 with one variety, and from 106.6 to 93 with the other. Germination rate was raised by SRI from 93 to 95 percent. Dry seed weight was boosted from 28.55 grams per 1,000 to 30.48, and the vigor index went from 26.54 to 28.89. Subba Rao commented that SRI methods are particularly good for growing hybrid seed. The wider spacing is not only beneficial to plant performance, but it reduces farmers' seed costs. His concluding remark was that with SRI methods, seed quality is "far superior."

Dr. R. Mahender Kumar also from DRR then gave a paper evaluating different **water-saving technologies** for irrigated rice production in India, subtitled 'SRI as a viable alternative.' He provided extensive data on the water-saving performance of SRI methods, showing how they can increase 'crop per drop,' a growing concern in India. I particularly appreciated his concluding comment that "creative solutions keep emerging." Farmers often encounter constraints that keep them from managing water as effectively and consistently under local conditions as is recommended for best results with SRI. However, once farmers understand the reasons for maintaining their paddy soil in mostly aerobic condition, they often find various ways to control and regulate their water applications.

The final presentation by **Dr. Shaik Meera**, also from DRR, was on 'E-Learning for SRI: Open and Distance Learning Modules'. This proposed ways for **using electronic technologies** in the spread of SRI. Meera perceptively characterized SRI dissemination efforts to date as primarily: (1) drawing on visual impacts of SRI, (2) isolated and scattered efforts to popularize SRI, and (3) traditional SRI training programs. His objective was to give farmers wide access at low cost to knowledge about SRI methods and results, allowing individuals to learn what, when and where they wanted to learn. Meera presented a prospective plan rather than field data, but he challenged everyone to think about how modern communication methods can be used for SRI, including chat rooms for SRI workers, debates on SRI, and systematizing feedback from trainees.

In the discussion period, I welcomed Meera's suggestions and said that CIIFAD, which currently supports a SRI web page (http://ciifad.cornell.edu/sri/) plus discussion groups structured for worldwide information exchange and participation, would be glad to cooperate with any efforts based in India. There is already a good SRI web page maintained by WASSAN for sharing information within India (www.wassan.org/sri/), and there is a new SRI web page supported by WWF (www.sri-india.net). All these efforts should be able to cooperate, which Meera agreed.

Meera also agreed that it would be better to conceive of electronic operations more as an effort for 'problem-solving' than as an 'extension' exercise – so that communication is more two-way. I noted that some Indian farmers are already in frequent e-mail communication with me at Cornell University in Ithaca, NY. Farmers are increasingly participating in e-communication, so our forward-looking efforts should aim to serve the farming community of the present and the future, not limited to what has been the situation in the past and present.

By the time all four papers were presented and discussed, we were far behind schedule, so the return to Agartala was in the dark, with nothing to be seen. It had been a very full and informative day, with the other three groups having as much stimulation and challenge as ours.

October 5 – Friday

The third day began with a session on reports and reflections from the previous day's field visits, which I was asked to chair. The report for Group I, which visited Matabari Subdivision, was given by **Biswanath Sinha**, program officer for the Sir Dorabji Tata Trust (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala16_GroupI_fieldtrip.ppt). About half of the population in the four villages visited are sharecroppers or marginal farmers. Of the 2,339 households in these villages, almost one-third (746) are already using SRI methods. (Two of the four villages, Barabhiya and South Mirza, are ones that Marguerite and I visited four days later, so for more information on these, see pages 9-10 and 13-14 of my trip report on these village visits (http://ciifad.cornell.edu/sri/countries/india/inntutrep1007.pdf).

Sinha said that SRI is now reported to be spreading without extension support in the villages visited. Further, "All the farmers interacted with reported they would continue practicing SRI even if the subsidy is withdrawn" which we were told by farmers during our Group III field trip. Village heads interviewed in all four villages reported incremental yields with SRI methods of 2.5 to 3 times, according to Sinha. It should thus not be surprising that SRI use has spread across caste and political affiliations. Sharecroppers were said to be taking the most care of their SRI fields. The group found best practice of SRI method in a village that has 95% scheduled-caste households.

Very active participation of the Panchayati Raj (local government) institutions, known as PRIs, was reported, as well as close collaboration of the Department of Agriculture. In support of his conclusion that "A real bottom-up approach was evident throughout the area," Sinha said that when he asked villagers to rank-order institutional support for SRI, they put PRIs first, then DOA, then the Government of Tripura. This was not a criticism of the latter two, which were said to have been also very helpful. But it verified the leadership role taken by local government

institutions. When asked to identify areas for improvement of SRI, farmers suggested: improving drainage systems, and pest control mechanisms.

The report for Group II which went to Melaghar Subdivision was given by **Dr. R. Rajendran** from TNAU (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala17_GroupII_fieldtrip.ppt). Their group of 50 participants visited three villages and met with 35 farmers, interviewing several at some length. Rajendran said that the participants received an "overwhelming reception" and were physically moved by the enthusiasm of farmers.

The first farmer, Vallab Debnath in Bagabasa Panchayat, said there were 40 ha of SRI in the area. Seeding rate had been reduced from 50-62 kg/ha to 5 kg. Eight to ten-day seedlings were being used, instead of 30-day seedlings, with one per hill, instead of 5-6. Compost was applied at 7.5 t/ha, plus 40 kg of NPK fertilizer/ha, down from 70 kg. Alternate wetting and drying was maintained. Yield as 7.5 t/ha with SRI, about double previous yield. If there had not been heavy rain at the start of the season, farmers expected the results would have been even better.

Mr. Chowdhary in Sonapur Panchayat reported a similar seeding rate and age of seedling. He applied 65 kg/ha of fertilizer, greatly reduced from 440 kg/ha previously. He uses a rotary weeder three times, 12, 24 and 36 days after transplanting, instead of doing two hand weedings. His yield is 9.5 t/ha, more than double his yield before. There is no lodging with SRI, and it matures 5-7 days earlier. There are more pest attacks, he reported, but these did not apparently affect his yield very much. His main constraint is having enough weeding, especially for weeding, and the time-bound operations put some pressure on him for management. But the results are considered well worth the extra effort.

Mr. Amirthalal Das in Indiranagar Panchayat likewise used 10-day seedlings, planted singly 25x25 cm spacing. His yield was 9.5 t/ha compared to 4.5 t/ha previously. His crop matured 15 days earlier, and he experienced lower pest pressure. Grain filling was good, with less chaff. "Only [enough] labor is a problem." (As noted above, I subsequently visited two of these three villages; for more information, on Indiranagar, see pp. 5-6, and on Sonapur, see pp. 8-9, in my report on these field trips after the Symposium.)

The Group III report need not be further discussed here, as an extended report is given above (pages 16-20). The Group IV report was given by **K.V. Gopal Rao** from the Agricultural Technology Transfer Center of ANGRAU at Kakinada in AP. There too, the visitors got a very warm welcome from the three villages they visited, Rao said. Thirty-five farmers were cultivating 25 hectares of SRI, and almost all of their crops had completed their tillering. Whereas traditional methods were producing 12-15 tillers per clump, with SRI, *Swarna* variety had 25-30 tillers per plant, and *Pooja* had 25-35 tillers. Leaf folder was observed in a big way with SRI, and some sheath blight was noticed; but other pest and disease problems were reduced. Purity of seed was a problem in this area as a lot of admixtures were seen.

Overall, yields with SRI were good, increased 25-30% over conventional methods, and there were also cost and other savings that made the changeover attractive. Farmers' approval of SRI

was “overwhelming,” Rao said. All said that they would keep using the new methods even without any subsidy. Some farmers have found SRI to be time-consuming, he added, but they now appreciate the benefits of monitoring their crop more closely.

After an hour’s discussion in which participants amplified on the reports and offered their personal observations, which were too many to report here, the session closed with comments by **Dr. S. N. Sen**, Tripura Director of Agriculture, who was sitting as its co-chairman. He reported on a statement that a deputy premier of China had made when he visited India a few years ago. The official said that with industrialization and the application of modern science, China had achieved in 15-20 years more than in the previous century. However, the damage done to their environment – their soil, water and air resources – has set the country back a century. So on balance, one might conclude that China had gone backwards.

Sen suggested that we are in “the midst of an imminent environmental disaster for the planet.” This should evoke constructive responses from all people and all sectors, particularly agriculture. As usual, the session (which had started late) had gone well beyond schedule, so the tea break was dispensed with, and we moved directly into the 5th technical session on **Institutional and Policy Issues**, chaired by **Dr. Chandrika Prasad**, Director-General of the Uttar Pradesh Council for Agricultural Research.

The session began with a presentation by **Dr. Biksham Gujja** (WWF) on ‘scaling-up of SRI’ [URL], starting from the concern that water shortfalls in countries around the world are growing in both quantity and quality and constitute a global challenge. Agriculture takes 70% of human extractions of water from natural systems, and water conflicts are growing almost everywhere. Picking up a metaphor that I had used in my comments on the first day, Gujja said that WWF has gotten “infected by SRI,” but this is a benign infection that can spread, often quickly.

WWF began evaluating SRI in 2004, working first with ANGRAU and then DRR. Their studies established that SRI “really works.” There was excitement over the results, as significant water-saving potentials were documented. SRI is now practiced in almost all states of India to some extent, Gujja said, and some solid research has been done, giving independent confirmation. Tripura State has demonstrated that rapid progress in spreading SRI is possible. However, still SRI is used on only a very small percent of the total rice area in India. There is some resistance from scientists and professionals continuing. However, government agencies and civil society organizations are increasingly working together in partnerships of many kinds.

Gujja proposed a goal of 20 million ha of SRI in India by 2020, with an estimated investment of Rs. 20,000 crores proposed ($50 billion). This projection, calculated at Rs. 2,500/ha, sounds like a huge amount, but the returns to SRI methods in just one year can be four times this amount. The economic analysis that Dr. Amrik Singh reported from first-year experience with SRI in Punjab showed a net income improvement of Rs. 10,000/ha. This was calculated before there was any reduction in labor requirements, which is increasingly reported by farmers and which would greatly increase this net income effect. So even enhancing farmers’ net income by one-quarter this amount, by Rs. 2,500/ha, would recoup the investment in just one year. Thus Gujja’s

proposal and concluding admonition -- Let's Advance Quickly 'More Rice per Drop' – were economically quite justifiable.

Next, **A. Ravindran** from WASSAN discussed 'Promotional Policies for SRI' (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala19_WASSAN_PromoPolicies.ppt). Ravi began by lamenting that "SRI is 'Nobody's Business'." By this he meant that no private or vested interests benefit from SRI, because it reduces rather than relies on external inputs. Being idea-based, there are no new inputs to promote or sell. Transfer of knowledge and skills is difficult and takes time, and extension services are trained to spread inputs rather than ideas.

Ravi presented two alternative approaches to scaling-up SRI. View #1 foresees slow, stable 'organic' growth of SRI. SRI may remain a 'niche' development like organic farming, with a strong but narrow clientele. The government role for this is just to support more training and farmer-to-farmer exchange, also developing communication materials. The main spread is through civil society initiatives.

View #2 prefers that SRI become the dominant paradigm for agriculture, taking over from the Green Revolution, which has provided for some years the main framework for research and extension. Unquestionbly, agricultural production in India is stagnating at present, and there is a serious crisis in the agricultural sector, with rising debt and pressures on farmers. (Everyone knew that he was alluding to the rise of farmer suicides, which puts pressure on politicians.) With this more ambitious approach, public investments should be made in 'drivers for change' and in expanded scale for SRI. Extension services would need to be reoriented to be able to spread ideas rather than things. Research would be redirected toward making systemic improvements in agriculture, not just piece-meal changes. On-station research would be supplemented and even superseded by on-farm activities, so that researchers interact more with farmers and with civil society. Government support should also be reoriented, from short-term, production-centered approaches to longer-term farming-systems improvements, seeking to ease constraints, both material and mental.

Obviously, Ravi favored the second approach. This would require systems for making implements like markers and weeders more easily available; making water supply more reliable in irrigated systems, able to provided the smaller amounts of water appropriate for SRI on an assured basis; systems corrections so that biomass production, pest management, etc. can be handled locally in an organized manner; givng farmers incentives for adoption, and underwriting mechanisms to protect them against risks in adoption; investing in infrastructure for drainage, land leveling, biomass production, etc.; providing training for farmers and laborers; giving appropriate price incentives and labor-wage incentives; giving subsidies as needed; and ensuring water and electricity supply. The main actors involved in SRI so far have been farmers, NGOs and researchers. It is time for administrators and policy-makers to get involved, as seen from Tripura experience. Ravi's concluding remark was: SRI needs critical minimum scale for concrete solutions to emerge and for take-off; state support is needed up to that point at least.

Then, **Dr. T. M. Thiyagarajan** from TNAU presented his thoughts on 'SRI in **Tamil Nadu**: Current Scenario'. SRI work started in this state at Tamil Nadu Agricultural University, and after pursuing a scientific understanding of SRI, there is no large-scale adoption of SRI in the state. SRI is a priority component in a new 2007 World Bank-funded irrigation project with the goal of 250,000 hectares of SRI area. The Department of Agriculture is promoting large-scale adoption in cooperation with the university.

Thiyagarajan presented in summary form some of the research results that had underpinned the institutionalization of SRI, including evaluation of pest and disease pressures. As others had reported, leaf folder increased, but other pests and diseases are reduced. Research on the use of *Pseudomonas fluorescence* in seed preparation and as a soil amendment showed this reducing rice root nematodes by 37.5 and 59.5%, while root-knot in both soil and roots was reduced by 61.3 and 62.8%. Farmer evaluations he reported from the Thamiraparani Basin and Cauvery Delta gave somewhat different but mostly positive results, e.g., 56% of Cauvery farmers thought that the mechanical weeder made weeding 'easy,' whereas 78% of the Thamiraparani farmers responded this way.

Pictures were shown of a drum-seeder being developed by researchers with farmers to modify SRI methods for direct-seeding, so as to save labor. This is giving satisfactory results, with not much trade-off of lower yield for reduced labor requirements. The overall message of Thiyagarajan's presentation from Tamil Nadu was that, after some initial resistance from researchers and farmers, the results obtainable from SRI methods can gain a favorable assessment which persuades government decision-makers to support SRI as well.

The last paper before lunch was by **Dr. S. Pushpalatha** from Pondicherry, chairperson of **Ekoventure**, considering the 'Impact of SRI in Combination with Effective Microorganism Technology.' (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala21_Ekoventure_EMwithSRI.ppt). This NGO has been working with very poor farmers, mostly women, in unfavorable circumstances with saline, low-fertility soil. In 2006, Ekoventure began working with SRI methods. There was initial resistance, but SRI's reduction in lodging from storms particularly impressed farmers.

Ekoventure has been introducing the use of Effective Microorganisms (EM) which was developed 20+ years ago in Japan by Dr. Teruo Higa. Higa formulated a mixture of co-existing organisms in a culture solution that has had many reported successes in agriculture, waste disposal and other applications.[1] EM is still controversial in many circles, including among some SRI colleagues whom I greatly respect. My skepticism was diminished, however, by the pictures that Pushpalatha had in her poster presentation (but did not include in her powerpoint

[1] EM combines (1) *lactic acid bacteria*, which produce lactic acid from sugars and carbohydrates and suppress harmful organisms, with (2) *photosynthetic bacteria* (*Rhodopseudomonas palustris*) which synthesize amino acids, nucleic acids, etc. from organic matter and harmful gases (H_2S), and (3) *yeast* (*Saccharomyces cerevisiae*) that can synthesize anti-microbial and other useful substances for plant growth from the products of the activity of the photosynthetic bacteria.

presentation). This technology evidently warrants systematic evaluation in combination with SRI practices. An interesting innovation by Ekoventure is its distribution of microorganisms through the irrigation water, using a plastic soda bottle to add EM solution to the water drop-by-drop, similar to intravenous glucose drips in a hospital. There is also a foliar spray used at 30 days

Farmers were relatively easy to persuade, Pushapalatha said, but getting laborers' cooperation was another matter. "You are making us come to the field every day," was the complaint. But once they saw the plant growth, they too took an interest. Women were trained through farmer field schools, and they in turn got their husbands persuaded, she explained.

Costs of production have been lowered by 20% with SRI, from Rs. 9,018/ha to Rs. 7,330; seed cost is reduced from Rs. 500 to Rs. 30, and transplanting cost from Rs. 1,350 to Rs. 900. Rice plants have responded magnificently; one plant had 84 tillers, all effective. (Achieving such a high rate of panicle formation associated with having elevated soil biological activity has been seen elsewhere.) Already some impact is seen in adjoining villages, where younger and many fewer seedlings are now being used with row planting. Use of the conoweeder is also spreading, Pushpalatha reported.

A table showing the distribution of yield increases over four seasons indicated substantial improvements. None of the fields had a lower yield with the new methods. An EM-Fermented Plant Extract is used to control crop pests, a decoction of leaves from 10-15 plants (papaya, neem, lantana, euphorbia, etc.) soaked in water for 7 days and fortified with EM solution. This has given good protection, Pushalatha reported.

Increase in yield (kg/ha)	Number of fields	Percentage
250-500 kg	22	11.9
501-750 kg	49	26.5
751-1000 kg	26	14.1
1001-1250 kg	18	9.7
1251-1500 kg	32	17.3
1501-1750 kg	8	4.3
1751-2000 kg	15	8.1
>2000 kg	15	8.1
Total	185	100

There was some skepticism from the audience about these methods, but the healthiness and productivity of the plants was certainly evident. Dr. Ravi from TNAU who works on IPM endorsed such organic farming methods, saying that neem has proven to be a good prophylactic for leaf folder, the one pest that seems not to be resisted so well by SRI plants. He called for a "knowledge alliance between farmers and scientists." **Jacob Nellithanam**, coordinator of the Richaria Campaign in Chhattisgarh, who has been using and evaluating SRI methods with local varieties, commented that such involvement between farmers and scientists is important because they are able to get yields of 6 t/ha with these traditional varieties, rather than the usual 2 t/ha, and the scientific community should be interested to try to explain these differences.

There was more discussion than can be summarized here, and even more issues that could not be raised and addressed for lack of time. Dr. Prasad as chairman noted that there are many subjects which warrant investigation. When he studied entomology as an agriculture student many years ago, there were 25 main pests to be learned. Now there are 250 pests, despite (or maybe because of) the extensive use of pesticides. He said that today's farmers should accept responsibility for leaving farmers for the next generation soil and crop systems "as good as the ones we inherited."

In the afternoon after lunch, the last technical session on **Policy and Extension Support to SRI** was facilitated by Dr. Gujja (WWF). He led off with a series of questions which panelists were invited to comment on. Dr. Viraktamath (DRR) observed that research in support of policy and extension should not be limited to scientists, as "SRI was brought without much research." It has been established that all of its methods are beneficial and work well, he said. But if it is not practical to use them all together, some adjustments must be made. This can be done by scientists and/or farmers. There were several comments that SRI should be viewed as working within a new paradigm for production, with implications for improving agricultural research and extension more generally.

Gujja's question about whether it is possible to undertake SRI within large irrigation systems, where farmers do not have their own water control, was given an affirmative answer by the two farmers on the panel, Krishna Rao and K.V. Rao. They noted that some adjustments usually need to be made, but "don't rule out the possibility."

Supporting their conclusion, I commented that in Indonesia, most of the >12,000 on-farm comparison trials included in an evaluation by Nippon Koei operated within large irrigation systems. By making adaptations like raised beds and/or installing drainage channels, farmers there had obtained an average increase of 3.3 t/ha (78%), while using 40% less water and 50% less fertilizer. SRI should not be considered as a fixed or finished technology but rather as a starting point for problem-solving to take advantage of the insights that SRI gives us about how to provide a better growing environment for rice plants.

My comments were supported by someone from the Godavari Delta in Andhra Pradesh who said that his area has abundant water which is often uncontrollable. Still, SRI has been successfully demonstrated there. The biggest problem is irregular and unpredictable water supply, which the government should deal with. A farmer from the Cauvery Delta in Tamil Nadu said that water can be shared in turns when it is scarce. Plants can survive considerable water stress provided that they have gotten their roots well established in the first days after transplanting.

On the question of whether government subsidies are necessary for SRI spread, Dr. Ayyangar, Tripura's Secretary of Agriculture, said that resources provided should be called an incentive, not a subsidy. His government is giving most of its support in-kind, e.g., as biofertilizers. I expressed the view that giving farmers 'subsidies' for adoption of SRI implies that it is not really in their interest, and that they need to be 'bribed' with some payment. There are alternatives to subsidization, such as a program that guarantees no losses from adoption, making up any shortfalls, which are extremely rare; or giving farmers easy access to appropriate implements, which are paid for by farmers themselves, but on easy terms; or paying farmers a higher price for

their SRI paddy, because it produces about 15% more milled rice, quite economically justifiable. Such measures are less costly and more sustainable than are subsidies.

Muazzam Husain from Bangladesh also expressed such a view, seeing subsidies as a non-permanent solution. Jacob Nellithanam from Chhattisgarh, however, suggested that since the Green Revolution paradigm has been highly subsidized, it is not reasonable to expect SRI as an alternative paradigm to compete successfully "unless the playing field is leveled." Trimurthy from TNU said that *Swarna* variety (MTU-7029) is being grown on 60% of the rice area in Chhattisgarh; with SRI methods, it gives 4 t/ha yield, without needing any nitrogen fertilizer; so there is no need for subsidy.

Someone in the audience said that other government programs are all giving subsidies, so why not SRI too? This was met with scattered applause. K.V. Rao reported from his experience as a farmer in Andhra Pradesh, "When we started with SRI in 2003, not a single farmer asked for subsidy." They did ask for implements, but these were important to help them get a higher yield, so farmers were satisfied. If the government wants to promote SRI adoption, "Let them procure SRI paddy with a better price," he said. "This would be only fair."

Chandrika Prasad, Director-General of the Uttar Pradesh Council for Agriculture Research, added that SRI farmers are saving a national asset in the form of water, so they should be rewarded in some way. There were various suggestions made either for or against subsidies, i.e., payments to farmers, for adoption of SRI methods. Clearly there was no consensus. Farmer opinion seemed to be that payments are not necessary for SRI adoption, but that subsidies should be considered fair in light of the benefits that SRI practice are creating.

The foreign participants were invited to make comments, and all said that they had learned a lot from the discussions. **Imad Shakawi** from Morocco said that expansion of rice production is the main threat to wetland areas in his country, so upon return, he and his colleague will start to set up SRI trials and demonstrations. Dr. Nurul Islam from Bangladesh said he had learned a lot and that Indian experience is very important for them, including methods for drainage in the wet season and better weeder design. Karma Lhendup expressed the hope that Bhutanese farmers can visit Tripura and other states to learn from their experience. Dung said that he had learned a lot for their SRI work in Vietnam from this visit to India. The role of farmer groups is particularly important. Their Farmer Field School program in Vietnam gets farmers doing experiments on spacing, varieties, etc. This helps in adapting SRI and also in persuading scientists of its merits. Heang Rattana from Cambodia said that government support is important for SRI spread, but not in the form of subsidies. They are finding in Cambodia that SRI methods can even reduce labor requirements, so this is a strong incentive for adoption.

The last question was about the kind of partnerships needed to move SRI ahead. Dr. Viraktamath (DRR) said good partnerships are essential for success. He likened the SRI movement to a vehicle, with NGOs and civil society organizations as the front wheels for steering, and said that researchers need to work together with them. The central government is like the rear wheels, providing power to the effort, "with Cornell as a fuel," he added. Dr. Ayyangar, Secretary of Agriculture, said there are no single reasons for success, with NGOs and research institutions

playing leading roles, but backed by political will and policy support, and with active local government institutions (PRIs) on the ground, all together constituting a dedicated team.

Ravi from WASSAN noted that the vehicle metaphor begged the question of: who is in the driver's seat? Many other views were voiced. One Tamil Nadu farmer, who pledged to "promote SRI personally," said that research should be oriented not only to small farmers but also to larger farmers and also to rural youth. "So many of the younger generation are leaving their homes," he said. "Any partnership should bring in the youth, both male and female," a good point on which to end this part of the program.

Dr. K.S. Rao from the Central Rice Research Institute gave a summary of the posters for the second day, many of which I had been able to view in the morning. One poster on 'Impact of SRI on Rice Farmers' in Andhra Pradesh, by Dr. V. Shashibhushan et al., reported that SRI's agronomic superiority was clear. SRI grain yields over three years ranged from 5.25 to 9.52 t/ha compared to 4.48 to 7.58 t/ha using conventional means; SRI straw yields were 4.36-7.17 vs. 3.82-6.64 t/ha, respectively, and some farmers had gotten yields as high as 13.2 and 13.7 t/ha. However, there was nevertheless considerable disadoption of SRI, as in this area, few farmers had continued with the methods through all three of the years monitored. The main reason for disadoption was problems with water control, especially when there were heavy rains in kharif season. Unfortunately, the poster gave no systematic information on the lack of continuity.

A poster on 'Grassroots Analysis of Adoption of System of Rice Intensification by Dr. Mangal Sain et al. from the Directorate of Rice Research reported on a survey of farmers in AP, Chhattisgarh, Karnataka, Madhya Pradesh, Punjab and Tamil Nadu during 2006-07. The total number of farmers covered was not given in the poster, but it reported that 60-90% of the farmers were satisfied with SRI, being good for enhancing rice production and productivity with less inputs. Reasons given were:

- Reduced seed rate (91%),
- More production with less input (83%),
- More head rice recovery during milling (83%),
- More tillers and panicles/plant (75%),
- More grain yield (75%),
- More straw production (75%),
- Higher grain weight (70%),
- Earlier maturity by 7-10 days (68%),
- Less insect pests and diseases (66%),
- More spikelets/panicle (65%), and
- Less water required (61%).

Constraints to adoption were assessed as follows:

- Transporting and transplanting young seedlings (71%),
- Non-availability of marker and conoweeder (53%),
- Water management (40%),
- Weed management (35%),

- Drudgery with cono weeder (33%),
- Non-availability of skilled labor (30%), and
- Less yield than conventional methods (22%).

The latter constraint was reported by farmers who had encountered problems such as uncertain supply of electricity for pumping water or unavailability of weeders, it was noted. On balance, farmers' assessments were quite positive, but there were a number of limitations facing farmers that need to be addressed for more widespread adoption.

A similar evaluation was contributed by Sreenivasa Rao et al. from ANGRAU in a poster on 'Force Field Analysis in System of Rice Intensification in Andhra Pradesh.' This conceptualization was derived from the American psychologist Kurt Lewin, and the data analyzed came from 200 SRI-adopting farmers in AP. The Rank-Based Quotients reported for 'driving forces' and 'resisting forces' were as follow:

- High grain yield (82.8),
- Low seed rate (81.2),
- Water saving (80.8),
- More tillers/panicle (79.6),
- Seed multiplication (78.7) and
- Low incidence of pests (77.8).

These are offset by difficulties with:

- Weeding (89.5),
- Transplanting (80.7),
- Water management (wetting and drying) (58.2),
- Limitations on organic manures (50.8),
- Skilled labour shortages (45.7), and
- Lack of implements for SRI (45.0).

SRI benefits were roughly proportional to the use of the recommended methods. The conclusion was that SRI could be popularized for widespread adoption "by weakening the resisting forces." These two posters put some numbers on the factors that favor or diminish SRI uptake which had been noted during the symposium.

The 'best poster' prize went to T.M. Radha et al. from the AME Foundation in Bangalore, reporting on 'Improving resource use efficiency through SRI – A case of Manadapalli' in Karnataka State. The report, based on analysis of 14 farmers' experience on 12.92 acres (5.17 ha), was very detailed, documenting good use of SRI methods, including 6-8 weedings and application of vermicompost and neem cake. Farmers' effort was well repaid as average SRI yield was 11.5 t/ha, an increase of 32%. With SRI, water use efficiency was increased by more than 2.5 times. Of particular interest to me was the AME finding that labor requirements were reduced. Further, seed multiplication with SRI was 2300 times as each kg of seed produced 2300 kg of grain. With conventional methods, this ratio was >20 times less, as only 100-120 kg of grain resulted from each kg of seed. Fodder yield was also increased by 22%.

Ekoventure, whose SRI experience using Effective Microorganisms in Pondicherry was reported above, had no computer-printed poster to present, only a set of enlarged pictures of training sessions and splendid rice fields. However, the beneficial effects of EM and other organic methods of management were evident at a glance to any participants who walked by.

It was unfortunate that there was not more time for everyone to spend time with each of the posters, interacting with their presenters. But also that there was not more time in the plenary sessions for all participants to share their ideas and experience. However, by the time that the concluding plenary session began, almost two hours late, there was a feeling of satiation that outweighed the feeling of frustration for most participants attending. Rapporteurs' summaries from each of the preceding technical sessions were anti-climactic and necessarily hurried.

The handing out of awards for 'best papers' and 'best posters' was more closely attended. The award for 'best paper' went to Dr. Padmavathi and colleagues at DRRI for their presentation on 'Insect-Pest Dynamics and Arthropod Diversity in SRI and Conventional Methods of Rice Cultivation' (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala22_PestswithSRI_DRR.ppt) [2]. A. Ravindra's paper from WASSAN 9

[2] There were also other interesting empirical presentations on pests, diseases and weeds. One paper presented to Group I on the second (field trip) day, by T. Ratna Sudhakar and P. Narsimha Reddy from ANGRAU gave similar evidence on the reduced incidence of pest diseases from field trials in rabi season 2005-06 and kharif 2006, such as thrips, hispa, stem borer, gall midge and whorl maggot observed in the control nurseries but only thrips in the SRI nursery; in the main field, there was no difference in which kinds of pests were observed, except no rodents during the vegetative stage. Yield differential in the rabi season was SRI 3.47 t/ha vs. 2.25 t/ha for the control, 54% higher yield; in the kharif season, SRI proved much superior under abiotic stress when a five-day cold spell affected the rice crop (down to 9.2-9.8^{o}C Dec. 16-21) ; control yield was 0.21 t/ha, SRI gave 4.16 t/ha (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala23_PestswithSRI_ANGRAU.ppt).

A paper presented to Group IV by T. S. Prasad and colleagues at the Directorate of Rice Research dealt specifically with nematodes (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala24_NematodeswithSR_DRR.ppt). In soil analyses by DRR scientists for two different rice varieties, root-feeding nematodes were found to be lower with SRI practices compared to both eco-SRI (organic) and conventional methods. In rice roots themselves, nematodes were lower withr SRI than conventional methods, although in some trials, eco-SRI had even lower infestation than SRI. The paper concluded that in SRI fields where no water control is possible, however, there is need to monitor for the root nematodes. It suggested that use of the cono-weeder might destroy the nematodes that have invaded the roots of weed plants; the incorporation of weeds and organic nutrients in the soil deters movement, migration and infestation by nematode pests; and decomposing organic matter promotes beneficial predatory and saprophytic nematode populations.

Another paper for Group IV, by S. Lokanadhan of TNAU, reported that while weed dry weight was higher with SRI at 20 days after transplanting, it was less than half as much at 40 days (6.04 vs. 12.90 kg/ha) (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala25_TNAU_Lokanadhan_ResourceUtiliz.PPT).

http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala19_WASSAN_PromoPolicies.ppt) received second prize, and Debashish Sen's paper from PSI (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala12_UttarakhandHPSI.ppt) was given third prize. As noted above, T.M. Radha's poster from AME got the 'best poster' award (http://ciifad.cornell.edu/sri/countries/india/TripuraPPTs07/Agartala26_AMEF_Poster.JPG) with the posters by Drs. Krishnamurthy and Lakshmireddy from ANGRAU and by Dr. Vijay Sharti from Jammu & Kashmir Agricultural University of Science and Technology getting the second and third prizes.

The concluding remarks by Dr. Gujja recapitulated what had been said and learned over the previous three days, and then Vinod Goud and Baharul Majumder gave impassioned 'votes of thanks' that turned into opportunities for participants to express their great thanks to these two persons who had done more than anyone else to organize the Symposium and bring it to a productive conclusion. There has been so many 'highs' during the three days that it was impossible for the plenary to close climactically. As participants vacated the SIPARD auditorium, a press conference was quickly held with Gujja, Ayyangar, Viraktamath and myself speaking briefly to journalists. The dinner time went until almost as late as the first night as people followed up unresolved issues from the day's discussions and/or took leave of old but mostly new acquaintances and friends.

October 6 - Saturday

Next morning, Marguerite and I had breakfast with Biksham Gujja to discuss ideas for how WWF and CIIFAD on behalf of the emerging SRI networks in India and around the world can follow up the learning and momentum accumulated by the Symposium. Then we met with Muazzam Husain and his colleagues from Bangladesh who were full of ideas and enthusiasm from what they had seen and heard in Tripura. Muazzam's report on the current status of SRI work in Bangladesh was summarized above. The good results of recent evaluations in farmers' fields supported by Oxfam Great Britain and ActionAid have been energizing, and the current Director-General of the Bangladesh Rice Research Institute appears more friendly toward SRI than his predecessors, some of whom even refused to let researchers work on SRI. The new DG for the Dept. of Agricultural Extension is definitely more supportive of SRI work, and the new National SRI Network has signed an MOU with DAE to cooperate on extension activities.

Abu Bakar Siddique Sarkar, a BRRI researcher who has taken a serious interest in SRI since 2000 when we first met, was in the Bangladesh delegation to the Symposium. He will soon start an agronomy PhD program at the Bangladesh Agricultural University in Mymensingh, planning to do his thesis on SRI. His faculty advisor will be Dr. Bajrul Islam, who was also in the delegation. Bajrul started SRI evaluations in 2002 after we met at a national SRI workshop in Mymensingh, and his experiments have given good results, he said. One trial with direct-sowing of germinated seed produced 8 t/ha, and some SRI plants had 86 productive tillers. The program officer from ActionAid who was in the delegation, Md. Mofizur Rahman, said that his NGO will try to send a team to visit Tripura before the next boro season, since agronomic conditions in Tripura are quite similar to those in some parts of Bangladesh. The whole delegation had quite evidently developed a sense of shared purpose and confidence that should help them to activate

the same kind of 'learning alliance' seen in India and other countries among NGOs, universities, research institutes, and extension agencies, all working more closely with farmers than was previously the norm.

Marguerite and I then had lunch with Imad Shakawi and other representative from Morocco sent by WWF to learn about SRI directly from practitioners and scientists in India. The rice sector is not large in Morocco, but it makes large demands on limited water supplies in the regions where rice is grown, and the country is a net importer of large quantities of rice. So they were very interested in trying out the new methods. That water is very expensive in the agricultural sector, and farmers have individual control over their supply, could make the rationale for using SR methods quite compelling.

That afternoon, Karma Lhendup from Bhutan, Marguerite and I made a visit to three villages northeast of Agartala city where farmers were using SRI methods, and then the next three days we made additional village visits. These are written up in a separate report that is posted on the internet (http://ciifad.cornell.edu/sri/countries/india/inntutrep1007.pdf). Then we spent a week in Bhutan with Karma visiting locations where SRI has been introduced or where evaluations are planned, this being one of the countries most recently taking up SRI methods. This also has a separate report.

POSTSCRIPT: October 17-19

Having returned to Delhi on the afternoon of Wednesday the 17th, after spending a week in Bhutan with Karma Lhendup getting acquainted with the SRI initiatives there, the next day I made a presentation on SRI to the 10th Inter-Regional Conference on Water and Environment being held at the Indian Agricultural Research Institute (IARI). This was arranged by **Dr. A.K. Singh**, previously director of IARI's Water Technology Centre and now IARI's deputy director. He has supported SRI evaluations at the Centre since learning about SRI in 2002. Several contacts were made for SRI follow-up, including one in the U.S. (Arkansas).

On Thursday afternoon, there was a two-hour meeting on SRI at Krishi Bhawan, headquarters for the Agriculture Ministry, organized by **Dr. Rita Sharma**, Additional Secretary for Finance and Administration. Rita has been interested in SRI for some time, being a Cornell alumna and having arranged the first seminar on SRI in India, which I was able to present at Krishi Bhawan in September 2000.

This afternoon meeting was certainly high-level, attended by two Government of India (GOI) Secretaries: **Dr. Mangala Rai**, Secretary for the Department of Agricultural Research (DARE) and concurrently director-general of the Indian Council for Agricultural Research (ICAR); and **Dr. P. K. Misra**, Secretary of the Department of Agriculture and Cooperatives (DAC), which has responsibility for planning and implementation in the agricultural sector, together with more than a dozen other senior officials from the two departments.

Dr. B. C. Viraktamath, project director of ICAR's Directorate of Rice Research (DRR), who had played a leading role in the symposium in Agartala, had come up to Delhi from Hyderabad for the meeting, and he gave a powerpoint presentation after mine. He was followed by Dr. Mukesh

Khullar, DAC Joint Secretary, who gave a powerpoint presentation on the plans that the Ministry has made to promote SRI under the GOI's new **National Food Security Mission** (NFSM) which is being launched to increase production of rice as well as wheat and pulses among the poor.

My presentation started with a review of the eight goals or challenges that IRRI's former director-general, Dr. Ron Cantrell, mapped out at the start of 2004 for the International Year of Rice: improved land productivity (higher yield); greater water productivity (more crop per drop); assured access of the poor to new technology (poverty reduction); environmental friendliness; resistance to pests and diseases; resistance to abiotic stresses (particularly drought and flooding); higher grain quality (for consumers); and greater profitability (for producers).

I gave reasons for how and why SRI can contribute to the achievement of **all of these goals**, presenting data and pictures from India to support this claim. The strongest data came from our field visit October 8 after the Symposium to Rajnagar Agricultural Subdivision in South Tripura district. There, local Agriculture Department officials gave us the following figures on the rapid (100-fold) spread of SRI use within a single year, based on SRI more than doubling yield.

	Area under paddy (ha)	Paddy production (MT)	Average yield (MT/ha)	Area under SRI (ha)	SRI paddy production (MT)	Average SRI yield (MT/ha)	No. of families involved
2005-06	15,613	49,976	3.009	24.5	170.079	6.942	122
2006-07	15,632	50,976	3.261	2,300	15,669.9	6.813	5,335

Already within two years, one-sixth of the subdivision's rice area had been put under SRI management, and Department staff expected to each one-third under SRI in this year, 2007-08, despite setbacks from severe flooding at the start of the season. Also, I reported on our visit to a tribal village, Dimatali in southern Tripura, October 8. Two years earlier, these farmers had not even been planting their rice in rows. Last year, the one-quarter of farmers who accepted the discipline of SRI management averaged 6.5 t/ha compared with others' conventional yields of 2.5 t/ha. Practically all farmers in the village are planning to practice SRI in the coming season. This indicated how SRI can benefit the poor, while giving savings of seed, water and capital.

Dr. Viraktamath's presentation enumerated factors constraining the rice sector, such as less per capita availability of land, deteriorating soil health, environmental problems, and rising costs of production. He laid particular stress on the water crisis, showing how per-capita water availability in India was expected to drop by 72% between 1955 and 2025. Since 80% of freshwater in India is consumed by the agricultural sector, and over half of that is consumed by rice production, there will be strong pressure to reduce the allocation of water to this sector.

The results of DRR trials over three seasons which Viraktamath reported did not show as great increases as have been reported from other countries – or as documented in Tripura state (e.g., in Rajnagar Sub-Division, reported above). Yield increases ranged between 7 and 42%, and averaged 15%, with significantly higher yields in only half of the DRR trials. However, these gains were achieved with a seed saving of up to 75%, and water reductions of 29%, according to

DRR evaluation, with large increases in farmers' profitability. So the 'bottom line' that was reported by Viraktamath was very positive.

Apart from yield data, Viraktamath reported that with SRI practices, there are: vigorous roots; increased microbial activity; reduced soil and water pollution; reduced pests (brown plant hopper and stem borer); greater grain filling; and high seed quality. He showed data on root mass and root density comparing differences between SRI and control plants that were quite dramatic, and also data on decrease in the incidence of pests, except for leaf folder and also root-knot nematode (no data given):

Pest	SRI	Conventional	Difference
Whorl maggots (%)	4.82	11.56	-58%
BPH (no./hill)	1.84	7.52	-75%
Gall midge (%)	2.72	4.52	-40%
Stem borer (%)	5.48	9.86	-44%
Leaf folder (%)	21.04	12.97	+62%

Viraktamath said that state governments in Tripura, Tamil Nadu, Andhra Pradesh, Karnataka, Punjab, Chhattisgarh and Orissa are already supporting SRI extension, and he suggested a number of priority topics for research. His conclusions were:

- SRI is one of the eco-friendly, input (water)-saving and yield-enhancing options for irrigated rice.
- Researchers, developmental agencies, NGOs, and irrigation departments have to work together for SRI dissemination.
- Large numbers of frontline demonstrations have to be conducted, and training needs to be imparted to both farmers and farm laborers.
- Farmers should be empowered to produce enough organic materials required for adopting full SRI.
- Strong policy support is needed to promote SRI.
- Tripura model can be adopted to popularize SRI in other states.

Mukesh Khullar presented "how we are looking at SRI in the National Food Security Mission," saying that the DAC's thinking has been shaped by success stories in Andhra Pradesh, Tamil Nadu, Karnataka and Tripura, and also by the demands coming from states which "want SRI to be made center-stage," as well as from the Department's own field visits. Data sets from Andhra Pradesh, Tamil Nadu, Karnataka and Tripura all showed yield advantages with SRI methods, from 1.2 t/ha to 2 t/ha on average, with lower water requirement and reduced costs of production, enhancing farmer income. Khullar said there are "tremendous successes that we have seen."

The National Food Security Mission plans to promote SRI extension to 5 million hectares of rice area in 133 targeted districts across the 12 states where the greatest food insecurity has been identified: AP, Assam, Bihar, Chhattisgarh, Jharkhand, Karnataka, Madhya Pradesh, Orissa, Maharashtra, Tamil Nadu, Uttar Pradesh, and West Bengal. Plans were described for 50,000 demonstration plots (0.4 ha each) established over a 5-year period, one for every 100 hectares within target areas. Five thousand Farmer Field Schools are planned, one for every 5,000

hectares, and each with 30 farmers who will serve in turn as trainers of other farmers. Also the purchase of conoweeders will be supported.

All together, over 1,500 million rupees, close to $40 million, are allocated to SRI extension. The main challenges that Khullar listed were:

- Development of curriculum of SRI for training
- Increased labor requirement – how to deal with this
- Weed management
- Availability of power for assured irrigation
- Knowledge sharing for adopting the global best practices.

On behalf of the network of individuals and organizations in India and elsewhere who have been working on SRI, I said that we will be glad to be of whatever assistance we can in this ambitious program because we want to see this succeed as much as anybody else does. We discussed how the effort can avoid rigidity and blueprinting, and how to make appropriate applications of new knowledge that is emerging, like how to reduce labor requirements and meet food security needs where they are greatest. I described direct-seeding versions of SRI in several countries and the success that the NGO PRADAN has had in Eastern India with 'rainfed SRI.'

In his concluding remarks, Dr. Rai noted that the key element in SRI success is soil biota. He made a good case for starting the extension in areas that are most promising, i.e., where there is well-leveled land and good water control. He recommended experimentation with laser leveling, a technology that colleagues in Pakistan have begun using with SRI, and also innovations in nursery management, such as mat nurseries, possibly at community level as he had seen being promoted in Vietnam.

He said: "If you can give rice plants the conditions that are recommended with SRI, there is no reason why yield should not increase." He said there is "no doubt" in his mind about this. There remain some practical problems for achieving these conditions fully and on a large scale, but the merits of SRI methods is not in doubt. Of course, there is need to pursue more scientific work to get a better understanding of the dynamics and of the potentials and possible problems.

"We cannot keep producing rice with 3000 liters of water for every kilogram," he said, adding that differential responses of different varieties to SRI methods should be investigated. "All will respond to SRI, but we should do screening under local conditions." One factor that he said had not been adequately mentioned was the growing impact of climate change. With SRI and reduced flooding of paddy fields, there should be less emission of methane gases.

If the SRI work proceeds with carefully chosen areas to concentrate initial efforts, using appropriate varieties on appropriate land, the results should be good. With organic fertilization, the plant can get more micronutrients. Getting more organic matter into the soil will be a challenge, but he noted that vermicomposting is starting to spread very fast in India. The whole biofertilizer concept is catching on, and there is "a sea change" in thinking and practice. He expressed support for SRI concepts, commenting on the changed physiology of crops that is so evident now with SRI practice.

In her closing comments, Rita Sharma observed that SRI is introducing some changes in the way that agricultural research and development are done, over and above the evident impacts on production and productivity. This is an innovation coming from civil society, where the technology did not originate "within the portals of scientific institutions." Moreover, it is not being taken "in a linear way" to farmers. There were many components and many actors in the knowledge system, and she appreciated that the GOI research establishment is responding positively to this opportunity, working with NGOs and with farmers to take advantage of SRI.

The Government of India has "stuck its neck out," she observed, mainstreaming SRI in this way with thousands of demos now planned for all across the country. There is need to develop quickly some agreement on what to tell extension personnel and what to tell farmers so that the message will be correct and motivating. There are also many researchable issues that need to be taken up seriously by all the relevant institutions.

Sharma reflected that when the Government of India some 40 years ago made a commitment to proceed with the improved varieties and inputs that made 'the Green Revolution,' there was certainly some risk. A willingness to accept risks and to proceed had paid off handsomely. We will all be part of a new experience, and we must learn how to make it succeed.

The next day, there was a meeting with Dr. T.K.A. Nair, Secretary to the Prime Minister, which was attended by Dr. Sharma, Dr. Rai, Dr. Misra, myself and Marguerite, as well as several other top officials in the Ministry of Agriculture. The firm endorsement of the efficacy of SRI methods by Dr. Rai was an important part of the discussion, as was agreement that this large-scale initiative should be phased appropriately, to ensure success from the outset rather than scale it up too rapidly before there was effective knowledge and experience to be shared with farmers.

One of the officials suggested a special SRI mission on rice within the larger NFSM, but it was thought the spread of SRI should be handled within the overall framework of the Mission, perhaps having some special committee or task force on SRI to oversee its application and extension. It was agreed that farmer participation needs to be elicited rather than commanded, and that local efforts should be undertaken with and through the multi-tiered panchayat system, as has been important to the spread and success of SRI in Tripura.

In the afternoon, Marguerite and I visited the headquarters in South Delhi of an NGO that has played a leadership role for SRI in Eastern India, **PRADAN** -- Professional Assistance for Development Action (http://www.ids.ac.uk/impact/asia/pradan.html). After a meeting in November 2002, PRADAN staff working with impoverished communities in Purulia district of West Bengal got 4 farmers to try the new methods. Next year, this number rose to 150, and an evaluation was done by the India Programme of the International Water Management Institute (IWMI), as reported the journal *Agricultural Water Management* (2007, 87:55-60). Within two years, the number of SRI users in Chhattisgarh, Orissa, Bihar and Madhya Pradesh as well as West Bengal was up to 6,500, with average yields of 7 t/ha compared to 2-3 t/ha before (http://ciifad.cornell.edu/sri/countries/india/inpuruliakh0607.pdf)

The founder and first director of PRADAN, Deep Joshi, has retired but continues part-time as an advisor and is very interested in supporting SRI extension, as is the deputy director, Nivedita Narain, who did her master's degree at Cornell 15 years ago. Both were pleased to report that the Bihar state government has offered to fund PRADAN extension work on SRI in that state to reach and benefit 25,000 poor households. Possibly other still sources of support can be found to expand PRADAN's successful development initiative. Several of its staff are currently studying at Cornell for master's degrees with Ford Foundation or Fulbright support. Some have been working with farmers to adapt SRI concepts and practices also to finger millet, main staple food of poor households in many rainfed areas of eastern India, with good results. Collaboration with PRADAN will surely become more important for the SRI movement in the future.

These last two visits were an appropriate way to conclude our Indian visit. One showed the central government willing to make a major commitment to SRI extension, and the other showed SRI knowledge and practice being carried to populations and crops that are most in need of greater food production and food security. These people live in environments that are already quite 'stressed,' with climatic conditions getting worse, and these households have not been well-served by input-intensive Green Revolution approaches. Water is scarce in most areas that the National Food Security Mission aims to reach and in those parts of Eastern India where PRADAN is working and expanding its program. These initiatives are emblematic of the new chapter that is opening for SRI in India.