System of Rice Intensification in India

Innovation History and Institutional Challenges

Dr. C. Shambu Prasad

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Preface

I first heard about SRI or System of Rice Intensification in 2002 while exploring food security options for India as part of an organisation's campaign strategy on sustainable agriculture. I recall being sceptical when my colleague fresh from her visit to the Philippines was sharing the excitement of this new innovation in rice cultivation and about an American professor from Cornell university who was sharing the new possibilities of growing rice without flooding with Philipino farmers. It then seemed rather distant in the Indian context. My scepticism turned into curiosity closer home a few months later when I heard about it from other friends and farmers in the drought-prone Anantapur district. The group that was initially interested in growing millets, was now keen to experiment with this new system of rice cultivation. Accounts of surfing the internet despite poor connectivity to learn about opportunities elsewhere had me clued in. I later heard the well-known organic farmer Narayana Reddy share his experiences on this new system of growing paddy with Anantapur farmers in the World Environment Day celebrations organised by the Timbaktu Collective. He was not selling a miracle cure to the farmers but inviting them to his farm to see for themselves and participate in this new system.

I later visited Timbaktu Collective to have a look at their experiments. An opportunity to further investigate SRI came when I was working at ICRISAT (International Crop Research Institute for Semi Arid Tropics) on innovation policy and a proposal that we had written on 'New Insights on Promoting Rural Innovation: Lessons from Civil Society' was accepted by DFID through the United Nations University, Institute of New Technologies (UNU – INTECH, now UNU - MERIT). I felt that there was something unique about SRI as an innovation in process that was worth exploring. By the time we got started on the work in late 2003, SRI figured prominently in discussions in Andhra Pradesh, thanks to the work done by ANGRAU (Acharya N G Ranga Agricultural University) in taking up field trials in many parts of the state. The SRI story soon became several interconnected and complex stories when preliminary field visits to Tamil Nadu, where the first official trials were done had very interesting though different experiences.

The politics of knowledge became intriguing when debates on 'Rice Wars' began to appear in 2004 which was declared the International Year of Rice (IYR), only the second time in

its over 40 year history that the UN had chosen a crop as focus. Indian results on SRI figured prominently in the debates even as the IYR celebrations and plans ignored SRI. What had started off as a remote event in a village in Anantapur soon began to have systemic dimensions involving 'rice wars' between scientists, tensions between research and extension, social and natural scientists, farmers and SRI practitioners, all of them participating enthusiastically and in more or less equal terms. Having done innovation and institutional histories of research organisations before, I soon realised that SRI was raising broader questions on the practice of agricultural research and its institutions with lessons much beyond the possibilities for the rice crop. There were, it appeared, dimensions of research practice raised by SRI which were being ignored by some of the restricted debates on whether super yields were possible through SRI by a simple substitution of current practice and in one cropping season. Tests of this kind to 'validate' SRI were being conducted by many rice research organisations with results that only seemed to confirm their biases, even as SRI seemed to be pushing them into questioning their assumptions about the rice plant.

This report is a revised and updated version of the aforementioned research study. There has been a demand from many quarters for the results of the study, its insights and for information on SRI and agricultural innovation. I am very grateful to Dr. Biksham Gujja and Shri Vinod Goud of the WWF dialogue team for wholeheartedly supporting the publishing of this report so that the continuously evolving story of SRI in India can be shared with the many actors involved even as it is being debated and discussed amongst a select scientific audience. Their encouragement on a project not directly supported by them is reflective of the spirit of open learning so much in evidence in SRI in India as elsewhere. While working on the report the dialogue project of WWF had just started its work on SRI. We have had many interactions on SRI and its prospects and I have had the privilege of being part of the meetings WWF has organised with scientists, farmers and NGOs – each bringing their rich perspectives. The project is worth an independent and separate study by research organisations interested in institutional change. Few projects that I know of have been able to bring such diverse partners together on a common working platform. Engaging the research establishment on practices such as SRI that on the surface appear to contradict some of the fundamental ways of growing rice, but actually present prospects for new knowledge, is indeed a challenging if not impossible task. It is to the credit of the WWF team that they have been able to carry forward this challenge by bringing science and people together with sensitivity while not compromising on scientific rigour.

My shifting to Bhubaneswar in July 2005 has meant that I have not been able to follow the story as closely as I would have liked too especially in happening Andhra Pradesh. Nevertheless in this report I have tried to capture some of the events in SRI in the past year. What has been fascinating about the SRI story is the way the picture has been changing with every cropping season. Newer field and even research insights are

making earlier observations dated. More than the actual results the entry (and in some cases exit) of actors – individual and institutional – and their patterns of interactions amongst each other is fast changing. This report, while being perhaps the first history of SRI in India, is thus bound to be methodologically incomplete in the conventional sense. However, as a strong advocate of participatory history writing, I urge readers who might notice omissions to please write to me so that the anomalies can be corrected and insights drawn from. That in fact would be in the spirit with which Fr Henri de Laulanié developed SRI in Madagascar, by making sense of positive deviants that he observed in the field.

This report would not have been possible without the complete support and participation of a team of researchers who contributed significantly in the field studies and understanding of SRI. Not all were trained social scientists, in fact, some were documenting for the first time. However, each one of them brought in his/her insights and intimate field knowledge, enriching the collective learning that we all had and I cherish. The collation of the various state reports into a single 'national' report presented several challenges and is reflected in the rather elaborate SRI Timeline. I would like to thank the team that worked on the case study, which included mainly Sitaramaswamy (Andhra Pradesh – his passion and knowledge on sustainable agriculture and SRI was difficult to keep pace with), Chitra Krishnan (Karnataka and Pondicherry) and Kavitha Kuruganti (Tamil Nadu and overall civil society). Chitra and Kavitha's reports and constant insights added immensely to my understanding of SRI. Rajee and Umashankari contributed to understanding the picture in Tamil Nadu through their field visits and Zakir Hussain for Jharkhand. Andy Hall of UNU- MERIT has been very encouraging in his support even as I was straying away from the main innovation story into the exciting details of SRI. The report would not have been possible but for his backing the case and its potential even as the details were sketchy to start with. Inputs from participants where the case was discussed have been quite useful. This includes the IWMI TATA Partners meet at IRMA Anand in February 2005, Institute of Development Studies, Sussex in March 2005 and the Rural Innovation Policy Working Group (RIPWIG) in New Delhi in May 2005 where the findings were presented to policy makers of government of India representing various departments and ministries.

Prajit Basu from the University of Hyderabad helped me understand scientific controversies better and worked with me on the SRI paper for the IWMI TATA meet at Anand in February 2005. Dr. O P Rupela from ICRISAT, who has taken the scientific agenda of SRI much further than many conventional rice researchers spared his time and helped in my appreciation of the scientific aspects, sharing with me Richharia's work on clonal propagation. Dinesh Kumar and Bablu Ganguly from Timbaktu Collective, G V Ramanjaneyulu, Ravindra, Suresh and Kishen Rao (from WASSAN and CSA) and K V Padmaja have all helped me at various stages with the report by freely sharing information and insights and providing very useful and relevant field contacts. I would

like to gratefully acknowledge all the farmers — too numerous to mention — who willingly shared their insights and understanding of SRI and the agricultural departments and extension staff of the various states who, in many instances, went out of their way to provide intimate information on local practice. I would like to acknowledge all the officials of the Department of Extension of ANGRAU and the district level officials who were most cooperative in providing information and sharing their extension work. Scientists and extension researchers of all the states covered in the study were indeed very helpful.

A special thanks to Norman Uphoff who was most willing to share information, reply to me and others despite receiving innumerable mails from the over 40 countries where SRI is being practised. He has shared and added so many nuances to the story and commented on field notes with undiminishing insight and enthusiasm throughout the writing of the report. He most graciously consented to write a foreword despite being on travel to SRI fields in South Asia with little internet connectivity. I would also like to thank my institute, the Xavier Institute of Management and my director Fr E Abraham for providing the academic environment and support that enabled me to continue pursuing this fascinating story. The usual disclaimers apply and none of the above mentioned are responsible for any errors in this report. I do hope this report will take further the discussions on SRI and agriculture in India and other countries of the South.

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Foreword

Innovation in the agricultural sector can come from a variety of sources. However, in the latter part of the 20th century, the most heralded improvements upon previous practice have come from scientific research whose results were converted into technological applications. The location and expansion of agricultural research in large, formal institutions after World War II eclipsed the earlier ad-hoc leadership in technical change that had derived from agricultural practitioners.

Yet, toward the end of the 20th century, there was a growing discomfort with the closed and unidirectional nature of this linear model of research → extension → adoption as sequential steps for raising agricultural productivity. The uptake of innovations developed in isolation from end-users was not as widespread as desired, and the limitations in impact were thought to derive not only from faults in the extension process. The nature of the innovations being produced by this system, although some were magnificent and magnificently successful, was not meeting all needs. The innovations usually benefited persons who were relatively more advantaged and well-placed compared to those who were less well-endowed and more marginally located.

Suggested alternative models had various designations such as participatory technology development, reliance on indigenous knowledge systems, farmer-centred research and extension, or the 'triangular' model of Merrill-Sands and Kaimowitz (ISNAR). This latter model called for equilateral, interactive relationships among researchers, extensionists and farmers.

While there has been growing support for such reorientations, there is not yet a consensus on what will replace the standard model for research and extension, which ascribes to researchers the key role of coming up with new and better technologies. It assigns to extensionists the role and responsibility for communicating innovations to farmers and gives farmer the role of adopters. This latter role implies a responsibility to accept whatever is presented as superior technology.

From a history of science perspective on technological innovation, the System of Rice Intensification (SRI), reviewed in the following case study by Dr. Shambu Prasad, is

instructive. This is partly because it doesn't fit the way that prior issues and debates have been formulated.

- SRI did not originate within the precincts of institutionalised scientific research. Rather, it stemmed from the endeavours of a remarkable individual working diligently and devotedly with farmers, using scientific method pragmatically rather than formally, and guided by observation and practice more than by theory and accepted scientific knowledge.
- At the same time, SRI challenges some of the new conventional wisdom that 'farmer knowledge' has great merit and can provide the foundation for further agricultural advances. Fr. Henri de Laulanié, the originator of SRI, found and demonstrated that the practices of (by now) billions of rice-growing farmers have been mistaken and counterproductive.

So the way in which SRI emerged was thoroughly original, which in itself makes this system of agricultural production worth considering.

However, more important is the fact that the innovation in its substance and implications is quite unprecedented. SRI methods raise, concurrently, the productivity of the land, the labour, the water and the capital that are employed in irrigated rice production. Such across-the-board gains in productivity have not been encountered before. This result is thought to be impossible by anyone who believes that there must always be 'trade-offs' and that there can never be any 'free lunch.' SRI thus presents a challenge as much to the premises of economics as to the previous research findings of agronomy.

Professor Vernon Ruttan, an eminent scholar on historical change in agricultural technology who has been observing the progress of SRI since learning about it at a Bellagio conference on innovations in 1999, has commented in personal communication that SRI appears to be an unusual case where, instead of science being the source of technology, technology is preceding science, which was the 'normal' state of affairs in bygone decades and centuries. Perhaps this accounts for some of the hostility that SRI has encountered in certain scientific circles.

The comparative analyses of technological change in agriculture by Hayami and Ruttan (1985) have showed the determinant influence of relative factor proportions in an agricultural economy. SRI takes on added significance if one considers how factor proportions are going to be different in this 21st century, compared to the preceding one.

- There is going to be less arable land available per capita, which will make less feasible and less economic the land-extensive, high energy-input strategy of agricultural production which is dependent on the availability of inexpensive fossil fuels.
- There will also be less water available to the agriculture sector. This resource is a requisite for all agricultural production, so agricultural systems will need to become less 'thirsty'.

- While there will be a larger total population, the labour force in agriculture is contracting almost everywhere. Raising labour productivity in agriculture will be an ever more urgent requirement, especially if mass poverty is to be reduced.

Additional considerations altering the shape of agricultural systems in the future will be:

- Agricultural success depends thoroughly upon favourable climatic conditions. Agriculture is threatened not just by global warming but also by increased variability in temperature and rainfall, with greater frequency of 'extreme events' that are devastating to production. Making crops more 'climate-proof' is becoming an urgent need.
- After a century of production that was increasingly dependent on agrochemical inputs for fertilisation and crop protection, environmental hazards deriving from such 'chemical dependence' are accumulating and need to be redressed.

SRI as an innovation comes at an opportune time as we must reconsider strategic directions for agriculture in our new century. By raising dramatically the productivity of land and water, so that more output can be produced with less of these inputs, SRI relaxes these fundamental constraints. Also, given recent and expected increases in energy costs, it is going to be difficult to sustain many so-called 'modern' technologies.

Initially SRI appeared to be labour-intensive, which looked like a barrier to adoption in most rice economies, although its great increase in labour productivity, the most relevant consideration, made it attractive for farmers nevertheless since enhancing the productivity of labour is most crucial to their income. Actually, it is now being found and documented that once farmers have learned and mastered SRI techniques, their labour inputs can be reduced in absolute terms, i.e. SRI can also be labour-saving as saving water and reducing costs of production. This saving could become a more important factor affecting adoption of SRI than other considerations.

Further, by enhancing plant root growth and the abundance and diversity of soil biota, SRI is producing plants that are more resistant to biotic and abiotic stresses, better able to withstand the effects of drought and storm damage and less in need of agrochemical protection or acceleration. There are benefits for the environment in terms of soil and water quality to be obtained from SRI.

We do not have a full understanding yet of why this 'free lunch' is now available to farmers. However, research and knowledge are accumulating that confirm the earlier hypothesis that the productivity advantages of SRI practices derive from changes in soil biology associated with changes in the management of plants, soil, water and nutrients (Randriamiharisoa et al. 2006). The larger root systems and changes in soil biota are having demonstrable and positive impacts on crop performance.

Much of the previous research on rice is not applicable to SRI because it was done on flooded rice growing under anaerobic soil conditions. The different management practices that constitute SRI produce very different and more productive phenotypes of rice from most rice varieties used so far. These plants function differently physiologically as seen from considerable research done by Chinese rice scientists on SRI. Further, it is important to recognise that much of the current knowledge in soil science has been produced under conditions that make it less informative for dealing with SRI performance.

In soil research it is common to first eliminate all organisms living in the soil, creating what are referred to as 'axenic' conditions that 'control' the ubiquitous biological dynamics in the soil. This prevents them from affecting and making more variable the chemical and/or physical parameters being studied. The word 'axenic' means that all 'foreign' matter has been removed from the soil, implying that the creatures which live there should be regarded as strangers, out of place, in their own habitat. This methodology means that cadaverous soil is being studied, and not the real, living soil in which crops grow.

It is quite true that the biological aspects of soil systems are much harder to study than the chemical and physical aspects. But complexity and difficulty are not sufficient justification for creating and proceeding with a truncated understanding of soil systems. SRI is underscoring the importance of understanding soil systems in their completeness, not privileging chemical and physical factors over biological ones (Uphoff et al 2006). Such an appreciation and application should enhance our agricultural production more generally, moving beyond rice.

As noted above, SRI derives from the life's work of Fr. Henri de Laulanié, who worked in the tradition of Gregor Mendel (who launched the science of genetics). Both proceeded through acute observation and careful record-keeping, driven by curiosity. Laulanié was motivated particularly by practical concerns with how to enable peasant farmers in Madagascar to feed themselves and their families with minimum reliance on external resources because the people he worked with could not afford many or any purchased inputs. His work was utterly pragmatic, not shaped by theory — although before entering a Jesuit seminary, he had been trained in agriculture at what was then the leading French school in this subject, so he knew basic agricultural science.

SRI can be considered as a civil society innovation, having been propelled mostly by NGOs, farmer organisations, and interested individuals so far. However, they have been joined by a significant number of persons in universities, research institutes and international organisations who have made important contributions to the understanding and practice of SRI motivated by their curiosity and goodwill rather than by the power and authority of their institutions. This different origin and mode of operation for SRI also should make it interesting as an approach that may be appropriate for agricultural innovation in the 21st century when societies are better educated and more democratised.

Dr. Shambu Prasad has made the introduction of SRI into India a subject for systematic investigation early on in that process. He recognised the potentially profound impact that SRI could have on Indian agriculture and on the people who participate in it as producers and/or consumers. He was interested in what implications this process might have for gaining a better understanding of technological change in agriculture and of the interplay between science and technology in these processes.

Dr. Prasad's far-flung efforts to track the different actors and actions give us the possibility of understanding history while it is being made, not just in retrospect, when initiatives, intentions and implications have to be reconstructed from memory and documents rather than direct observation and fresh recollections. This gives more life and validity to such contributions to the history of science and technological change.

SRI is still an unfinished chapter in what is a never-ending book of agricultural innovation. What has been known as 'modern agriculture' is not the last chapter in that book, no matter what its designation had connoted. Given the factor relationships and trends that are foreseeable for this new century, we are now entering a phase that is still not clear or finished, but that can probably be understood as 'post-modern agriculture'. SRI will be part of that new phase, but we cannot know now where or how that phase will end – to be followed by yet another down the road.

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System of Rice Intensification in India: Innovation History and Institutional Challenges

The System of Rice Intensification, or SRI for short, is a fascinating case of rural innovation that has been developed outside the formal rice research establishment both in India and the rest of the world. This report documents the history of this practice in India in the last few years and presents some of the institutional changes and challenges that SRI throws up. This report is in three parts. The first part looks at the complex and continuing evolution of SRI in India and presents SRI as an innovation in process and not as a completed product. Farmers and other actors are continuously shaping it through their practice. In Part Two I use some of the insights of the innovation systems framework to understand SRI by looking closely at the nature and quality of linkages of the various actors. I conclude by highlighting some features of SRI in India and its implications for pro-poor innovation.

For the study the SRI crop was followed in two seasons, Kharif 2004 and Rabi 2004–2005 in a few southern states. The inputs and insights from the field were corroborated through detailed interviews with key stakeholders in SRI, involving structured and semi-structured surveys with farmers and other stakeholders. The study has relied on interviews with over 250 persons in India covering the southern states of Andhra Pradesh, Tamil Nadu and Karnataka as well as the union territory of Pondicherry and a diagnostic survey of SRI in Jharkand. Along with these interviews and field visits, the study has relied on extensive research of available material on SRI, primarily from the SRI website hosted by CIIFAD and Tefy Saina, and has followed the debates on SRI, placing it within the larger context of the International Year of Rice 2004 and SRI's neglect by the research establishment. The primary study has been updated and revised to account for some of the recent developments in SRI in Andhra Pradesh, especially the WWF dialogue project and also some field-level insights from a state where SRI is new – Orissa in eastern India.

Complex Evolution of SRI in India

The System of Rice Intensification, or SRI, is a system that has evolved over the last few decades of the 20th century and offers a radical departure in the way of growing more rice with fewer inputs. It was developed in Madagascar by Fr. Henri De Laulanié, a French priest with a background in agriculture and passion for rural development, whose keen observation of deviant practice and continued experimentation led to SRI emerging over a decade with six principles of growing rice that were different, often radically, from conventional rice cultivation techniques.

Civil Society Origins of SRI

In 1983, a drought year, at the small work-study school that Laulanié established, young farmers reluctantly transplanted some rice seedlings that were much younger than what they had been using. They transplanted 15-day-old seedlings, a quarter the age of those used in traditional cultivation. Yet, the plants were vigorous. Laulanié then tried these experiments adding other known experiments where farmers were not flooding their fields. He also added a practice of his own – that of distant spacing of single seedlings. The System of Rice Intensification or SRI emerged as a set of six practices:

- Transplanting of very young seedlings between 8 and 15 days old to preserve potential for tillering and rooting;
- Planting seedlings singly very carefully and gently rather than in clumps of many seedlings that are often plunged in the soil, inverting root tips;
- Spacing them widely, at least 25 x 25 cm and in some cases even 50 x 50 cm, and in a square pattern rather than in rows;
- Using a simple mechanical hand weeder ('rotary hoe') to aerate the soil as well as to control weeds;
- Keeping the soil moist but never continuously flooded during the plants' vegetative growth phase, up to the stage of flowering and grain production.
- Use of organic manure or compost to improve soil quality.

These principles, perfected over a period of time in Madagascar, surprisingly gave very high yields, in some instances close to 20 tonnes per hectare, with much reduced inputs of seed, water, fertilisers and pesticides.

Laulanié presented his results after nearly twenty years of work for the first time publicly in a seminar in 1989 to a large group of individuals (several representatives of NGOs, government extension agents, scientists, and the Minister of Agriculture himself), a presentation that was part of his philosophy on rural development. One of the fallouts of the seminar was the setting up of Association Tefy Saina (ATS) in 1990 that was established as a non-governmental organisation to give practical effect to his ideas. The Association's Malagasy name literally means, in English, 'to build the human spirit through a change in mentality'. This concept places men and women at the centre of a development process, emphasising self-help rather than dependency. The Association was to provide a permanent platform of information exchange for autonomous rural development. This allowed them to organise annual rural development seminars that brought together farmers, engineers, state extension agents and NGO technicians. This vision of ATS in getting various players in the sector together is often not sufficiently appreciated in the SRI literature that has in many instances tended to get carried away by the high yields of SRI, ignoring the institutional process that enabled this innovation.

SRI, however was unknown to the rest of the world. In 1994, an integrated conservation and development project (ICDP), around Ranomafana National Park, made it possible for Tefy Saina to begin working with the Cornell International Institute for Food, Agriculture and Development (CIIFAD) to disseminate and evaluate SRI and other technical innovations in that region. This important partnership that began with a view to increasing the yield on lowland rice fields and weaning farmers away from slash-and-burn cultivation was critical in enabling the spread of SRI initially in Madagascar, but more importantly to the rest of the world. What until 1999 was a local phenomenon became a global movement with farmers in 22 countries taking to SRI in varying degrees. This spread is remarkable, considering that SRI met with and still meets with stiff resistance from the agricultural research establishment and has but little formal support in most countries. Resistance to SRI has been on the methodology which scientists still struggle to understand and perceptions of SRI as backward.[1] Following its rapid spread especially in Asia, it was possible for CIIFAD

[1] The first trials validating the methods outside of Madagascar were done in 1999, in China and Indonesia, and have now been validated in 22 countries. In countries such as Laos, Nepal and Thailand, 'the SRI effect' was not very evident initially (though it was subsequently seen). In other countries, such as Cambodia, Cuba, Gambia and Sierra Leone, there were very dramatic results. The Agency for Agricultural Research and Development (AARD) in Indonesia was amongst the earliest organisations that sought to promote SRI in collaboration with CIIFAD, deciding in 2002 after three years of evaluations to make it part of a new Integrated Crop Resource Management strategy to restore growth in the rice sector that had been lost as Green Revolution technologies were stagnating in that country. The Sukamandi rice research station where SRI trials started had been one of the main centres for Green Revolution research during the 1970s and 1980s. NGOs and farmer groups as well as university and government researchers in a number of other countries started testing SRI (Rabenandrasana 1999; Uphoff 1999, 2002, 2004; Berkelaar 2001; Stoop et al. 2002).

and Tefy Saina to hold an international conference on SRI in China in 2002 to pool in experiences from 15 countries. It was hosted by Prof. Yuan Longping, director of the China National Hybrid Rice Research and Development Centre and popularly known as 'the father of hybrid rice,' who had demonstrated the merits of SRI at his centre.

The above historic evolution of SRI is to reiterate the civil society origins of SRI in a country where NGO activity was and still is quite rare. SRI for ATS was to play a pivotal role in translating its long-term vision of development as a process of improvement of human capacities and motivation. The genius and perseverance of Fr. de Laulanié was undoubtedly the spirit behind SRI, but it also, as Lines and Uphoff comment,

'Required the manifestation of civil-society thinking and initiative to keep alive this opportunity, which was dismissed by government agencies and international experts when they first learned about SRI. Such a remarkable story is unlikely to occur very often, but we will never how often such opportunities have been buried by the heavy hands of authority and expertise, not valuing the kind of independence of spirit and liberty of thinking that have gone into SRI and its promotion' (Lines and Uphoff 2005: 19).

It is interesting to note that the vision of ATS that sought to address the social and psychological aspects of poverty was very often ignored in poverty measurements. Poverty reduction to ATS was more about empowering the poor through new ways of doing old things such as growing rice.

SRI in India: A Slow Start

India is one of the largest producers of rice in the world; however, rice cultivation in recent times has suffered from several interrelated problems. Increased yields achieved during the green revolution through input intensive methods of high water and fertiliser use in well endowed regions are showing signs of stagnation and concomitant environmental problems due to salinisation and water-logging of fields (the grain bowls of India Punjab and Haryana are some of the worst affected). In other parts there have been social conflicts between water users in several canal-irrigated areas due to the water intensive nature of the crop.[2]

However, unlike other rice-growing nations, India had a rather delayed start in SRI. T. M. Thiyagarajan of the Tamil Nadu Agricultural University, Coimbatore was the lone Indian representative at the 2002 international conference on SRI. He first heard about SRI in 2000 from Dr. Ten Berge of Wageningen's Plant Research International and was interested in the soil aeration aspect of SRI, and its water-saving potential. The

[2] The Cauvery water dispute between the rice-growing states of Karnataka and Tamil Nadu is a good example of social conflicts around water. Less reported are intra-state conflicts in many irrigated areas.

'modified' SRI practice that was evaluated by TNAU used three of the SRI principles (single seeding, wider spacing and use of weeder) but it used water and fertiliser in excess of normal SRI recommendations. The results indicated considerable water saving through modified SRI and a reduction of seed costs, but no significant increase in yields (Thiyagarajan 2002).

A closer look at the data on yields of SRI trials from various parts of the world following the international conference at Sanya, China indicates that SRI yields in India were in fact lesser than conventional rice yields (Nepal, Laos and Thailand too had such results) . These initial results would have been sufficient reason for rejecting SRI as an option for rice in India. However, choices made by farmers and other actors are often complex than mere economic and productivity considerations. The story of SRI can be seen in two parts: one, the official reading by the research and extension departments especially of the southern states, and two, a more complex evolution as this study reveals, with civil society activities and innovations throughout the period.

The detailed timeline of the evolution of SRI in India is provided in Appendix 1, which places all developments on SRI in India in one frame. The appendix reveals the complexity of SRI evolution in India bringing to the fore the almost parallel movements in SRI, one by the state agencies and the other by civil society. In states like Tamil Nadu, the region that is credited with bringing SRI to India, SRI is referred to by these actors differently, the state agencies and research establishment refer to it as 'Thirunthia Nel Sakupadi' (transformed rice cultivation) whereas NGOs have been popularising it as 'Ottrai Naatu Nadavu' (single seedling method).

Following Thiyagarajan's participation, Norman Uphoff visited India in May 2002, to present the prospects of SRI to agricultural officials in the southern states of Andhra Pradesh and Tamil Nadu. As a result the departments agreed to send professionals to Sri Lanka for a visit sponsored by CIIFAD to learn about SRI from farmers who were using the methods successfully. Uphoff also tried eliciting interest from other states like Punjab indirectly but the efforts were not successful.[3] Later in the year, in November 2002, Uphoff made a presentation on SRI at the 2nd International Agronomy Congress held in New Delhi as well as to top officials in the Ministry of Agriculture. The Acharya N.G. Ranga Agricultural University (ANGRAU) in Hyderabad sent its director of extension and a regional director of research to Sri Lanka in January 2003, a visit that was a landmark in the history of SRI in India. Alapati Satyanarayana, the director of extension, an initial sceptic of SRI, returned with a passionate zeal and emerged as one of SRI's strongest proponents, not only in India, but also in debates on SRI throughout the world (see Box 1).

[3] Punjab, one of the leading producers of rice in India, has evinced little interest in taking to SRI though there are reports by farmers and civil society organisations of farmers adopting wider spacing and non-flooding. Many of these farmers have not heard of SRI and in some instances tried getting the local agricultural officials to look at their experiments, to no avail.

Box 1: Reworking Knowledge: How a Sceptical Scientist Turned Proponent

Alapati Satyanarayana was deputed by the Government of Andhra Pradesh to visit Sri Lanka to learn about SRI. Dr. Satyanarayana initially resisted visiting Sri Lanka, partly given his expertise in pulses (he was one of the co-recipients with ICRISAT of the prestigious King Badouin award in 2002 for development of drought-resistant pigeon pea) and also because he hailed from parts of Andhra Pradesh that had been growing rice successfully for centuries. For ten years, he had been director of the research station at Lam near Guntur, which serves 1.2 million ha of rice-growing area. In any case, learning from Southern countries was hardly the norm in the Indian agricultural establishment.

Satyanarayana went to Sri Lanka with much scepticism about 'new ways of growing rice'. An accident, however, transformed him. He cut his finger while stroking the paddy stalks and realised that there was something fundamentally different about these paddy fields. Never before had he come across paddy fields where the blades were so strong and rough. Enquiries revealed that the varieties were not the reason. His host, a Senior Assistant Secretary in the Ministry of Agriculture, then took him to see his own SRI crop. This official, who was not an agriculturalist by training, was promoting SRI evaluations purely as a personal effort because the rice scientists in the Department of Agriculture were blocking any official association with SRI (the official wanted to have some personal experience with and demonstration of the methods). Satyanarayana saw that his host's paddy field, unlike the neighbouring fields did not suffer from the prevailing drought. When he took a panicle of rice from his host's field at random and one from the adjoining field, he counted the grains on each: the SRI panicle had 500, the conventional panicle only 120.

Satyanarayana started making connections and realised the importance of the genotype-environment interaction (G x E) that contributes to improved yields. Over the next few days Satyanarayana used the field experience to try and think through the science that had made this possible. He returned to India determined to try SRI out in Andhra Pradesh in a big way and established over 300 trials in different agro-ecological regions across the state during the kharif 2003 season, demonstrating the feasibility and desirability of SRI to farmers in India and the world scientific community (Satyanarayana 2004). The story of Alapati Satyanarayana's conversion to SRI is of interest for the connections that practitioners of SRI, farmers, researchers and others have been able to make to take the SRI agenda forward.

By this time in Tamil Nadu, a state that was facing a crisis due to declining rice production owing partly to reduced inflows in the Cauvery basin, the trials at TNAU attracted official attention. The Minister of Agriculture visited TNAU's SRI plots in October 2002, following which the state government made a grant of over $ 50,000 for SRI promotion and evaluation in the Cauvery delta and the government now seeks to have SRI methods used on 25% of the paddy area in 2004-05.

TNAU organised a conference on 'Transitions in agriculture for enhancing water productivity' at Killikulam in September 2003, jointly with Wageningen University and IRRI. SRI was discussed during this workshop and the most knowledgeable and enthusiastic reports were those from organic farmers who had previously heard about SRI through NGO connections and were using the methods.

An Alternate History of Innovation Networks

SRI in India has, however, figured for much longer than the field trials by research or government establishments. The current study has revealed that there has been a longer and richer 'untold' history of SRI in India outside of the formal agricultural establishment where civil society has played a prominent role. By civil society here we mean not only organised, activity of some Non-governmental Organisations or NGOs but autonomous activity by farmers groups and farmers of various categories (conventional rice farmers who have been growing rice, farmers who want to grow rice but cannot due to lack of water, farmers who are keen on experimentation, first-time SRI farmers, adapters, etc.) as also certain groups and individuals who are not directly involved in farming activities but who have played an important role in the system and are likely to do so in the years to come.

Speaking to various farmers, scientists and people involved in rice cultivation in India it is apparent that SRI is not something altogether new to India. It does seem to follow some prevalent practices of dryland farming. Many SRI innovators referred to R H Richharia's work on rice and biodiversity in the context of SRI. Several farmers and NGOs interested in sustainable agriculture seemed to have tried out, with varied success Richharia's suggestions on clonal propagation, a technique that he first developed in the 1960s at the Central Rice Research Institute at Cuttack (Richharia 1987). Richharia then was of course unaware of the possibilities that SRI offered and it is probable that the combination and synergistic ideas of SRI might have yielded better results to Richharia and later to other farmers keen on biodiversity conservation and native varieties of rice. It would be appropriate to mention Richharia's work here for it is a similar combination of innovative rice science and civil society experience that a few decades later rooted SRI in India.

The small union territory of Pondicherry in southern India, a small dot on the rice map of India, is perhaps the earliest place to have experimented with SRI. Auroville, the international commune that has been in the forefront for reclaiming degraded land and

one of leaders in sustainable agriculture, was among the first civil society organisation in India to have taken up SRI. They heard of SRI in 1999, by way of a pamphlet in French brought from Madagascar by a visitor to Annapoorna farm. This farm, which has been organic since 1987, tried small experiments with SRI on traditional varieties of paddy from 1999 to 2003 with unremarkable yields.[4] In 2000, news about SRI reached Pushpalata, owing to her close contacts with Nammalvar an organic farmer in Tamil Nadu and Herbert, who tried out SRI at Auroville. She had set up the NGO, Ekoventure in 2000, and had established credibility with a few farmers in Pondicherry. Curious yet unsure of SRI, she encouraged a women's group and a farmer, Ramaswamy, to try SRI on a few cents of land in samba 2001. His trial results spurred her on to take up SRI in 4 villages in 2002-03. In 2002 another big NGO, the Chennai-based M.S. Swaminathan Research Foundation (MSSRF) tried SRI on small plots in its 'biovillage'. Raasu, a small farmer looked after the SRI plot and later tried out SRI on his 30 cents of land, despite having no own source of water, buying it from others' fields. This case is noteworthy in that a small farmer who has to buy water for irrigation decided to try SRI on his own.

In neighbouring Tamil Nadu, SRI appears to have begun in Erode around 1999-2000. Some printed material on SRI was given by Mr. Nammalvar, a well-known organic agriculture activist and a leading person of the LEISA (Low External Input Sustainable Agriculture) network, to Mr. Ramaswamy Selvam, the current President of All India Association of Organic Farmers. Mr. Selvam tried out SRI in August of that year.[5] While this was in 1.10 acres of land, Mr. Selvam could have tried out SRI one year earlier, in 1999, on a much smaller scale, on 5 cents of land. In 2001, 40 more farmers tried SRI, after interaction with Ramaswamy Selvam. There were mixed results, due to water shortage and 'because the farmers used tractors to pulverise the land'.[6] Due to water scarcity and drought, the experimentation with, and spread of SRI outside the governmental system did not pick up in the following year.

SRI in Karnataka too originated from civil society and has been led by a network of the organic farming community that includes several NGOs and some of the country's leading organic farmers. Narayana Reddy, one such pioneer has taken on the spread of SRI as a mission. He considers it as the 'innovation of his lifetime'. He heard of SRI in 2001 through a CIIFAD advertisement, while in France for a conference. After a thorough study of SRI through available literature and a visit to the experimental SRI plot at the T S Srinivasan Centre for Rural Development Training close to Bangalore, he was excited about SRI and shared his zeal with his network of farmers and NGOs. He seeded half an acre to the

[4] Trials showed greater root mass (up to three times larger) and more tillers with SRI and the plant looked stronger but this did not translate into higher yields for SRI. High alkalinity of the soil seems to have been a factor.

[5] Narrated in a letter dated 25 December, 2002 from Mr. Selvam to Dr. Norman Uphoff.

[6] In the first year, Mr. Selvam did not get very good results – though water use came down – since he had used 22-day-old seedlings. The paddy was cultivated without any application of organic manure and was sown after harvesting jowar. His crop withstood water stress and the yield was 2507 kilos for 1.10 acres (6.25 tonnes/ha). Personal communication with Kavitha Kuruganti, 17 August 2004 and in his presentation during an international symposium organized by TNAU in September 2003.

hybrid variety KRH2 in 2002. Reddy shared his experiences with Dwarakanath, an ex Vice Chancellor of the agricultural university in Bangalore, who later encouraged the university to take it up.

There have been efforts of civil society involvement in SRI in Andhra Pradesh and West Bengal. Uphoff's presentation on SRI in New Delhi in November 2002 also drew attention from the NGO PRADAN (Professional Action Development Action Network), which took up SRI work in Jharkand and West Bengal. One of the first SRI trials in Andhra Pradesh came through Narayana Reddy who spoke about it to farmers in a celebration of the World Environment Day by the Timbaktu Collective in Anantapur district. Timbaktu later organised farmers' visits to Narayana Reddy's place and took up experimental cultivation in small plots in 2002. The collective, like many others, also collected information on SRI through the Internet and found very useful and relevant. Earlier an enthusiastic agricultural commissioner, Dr. Ajay Kallam read about SRI and carried probably the first ever article on SRI in India (Kallam 2001).[7]

In all these efforts by civil society the source of information in the first few years has not been from the rice establishment but from fellow farmers, the Internet, a combination of the two and by practical experimentation. The early adaptors of SRI were often farmers with a difference, not all were traditional farmers or from farming families, in fact some received information on SRI from non-farmers who were enthused by what SRI seemed to represent, namely a shift towards sustainable methods of farming and less reliance on chemical inputs. Many took to SRI due to its potential for innovation. Some of the early SRI innovators have been those whose primary identity has been varied — a homeopathic doctor, plastic surgeon, software engineer, retired High Court Judge, borewell driller, etc.[8] SRI had already seen many institutional innovations by civil society. Apart from experiments which in many cases started off with traditional varieties of rice, there were cases where SRI started with women farmers very early. Training methods also indicated greater emphasis on farmer-to-farmer exchange with groups like the Timbaktu Collective involving women in these exchanges.

Acceleration of SRI: New Actors and Partnerships

Though a late starter, there has been rapid spread of SRI since 2003 with the entry of a number of actors and newer partnerships. Interestingly, in many states it is the irrigation and not the agriculture department that has taken the lead. In Pondicherry and Karnataka, SRI has been taken up as part of tank rehabilitation activities. Pushpalata of Ekoventure joined the Tank Rehabilitation Project (TRP) of the government of Pondicherry and as a

[7] Kallam also organized a meeting with officials to share the method but no trials were undertaken. He could not pursue his interest due to a posting outside agriculture.

[8] The organisations involved are Centre for Indigenous Knowledge Systems (CIKS) in Nagapattinam and Tanjore districts; LEISA network in Trichy and Pudukottai districts; AME Foundation in Trichy district and VOICE Trust in Trichy and Perambalur districts.

consultant on gender and income generation has promoted SRI. The TRP interestingly is the only case where SRI has been celebrated as part of the International Year of Rice (2004).[9] A field school for 40 women was also conducted and a contiguous patch of 10 acres around the field school site adopted SRI during samba 2004. SRI is expected to spread to 500 acres by 2005. Ekoventure has taken forward the work on SRI through the EU funded Green Post Tsunami action extending its work in Pondicherry to four districts of Tamil Nadu. SRI is sought to be combined with EM (Effective Microorganisms) technologies to rehabilitate/ improve soil microbial life, which has suffered from the salt. Plans include setting up 60 model SRI farms per year and the training of community organisers as facilitators for the Farmers Field Schools. [10]

In Karnataka an important actor entered the SRI innovation system in 2003. This was the Community-Based Tank Management Project Consultancy Services (CBTMPCS), a centre at the Agricultural University in Bangalore funded by a World Bank project. They have taken on SRI as part of their water management component. CBTMPCS was introduced to SRI by Professor Dwarakanath, former Vice Chancellor of the University and an erstwhile student of Norman Uphoff. Two scientists were engaged full time to download and study all material on SRI and were encouraged to learn from farmers such as Narayana Reddy. This led finally to a decision to go in for direct seeding and the practice was re-christened SIP — Semi Irrigated Paddy. (They regard SRI as involving puddling and transplanting and distinguish it from SIP.)

The states of Andhra Pradesh and Tamil Nadu have by contrast seen more involvement by the state universities and agricultural departments. TNAU conducted 100 adaptive trials. In 2003-04, outside the government system, more NGOs started picking up SRI as part of their work.[11] The scaling up of SRI, outside the research system began in Tamil Nadu for the first time through the Department of Agriculture. Beginning August 2004, SRI was promoted under the 'Integrated Cereal Development Programme-Rice' with a target of 9000 acres to be covered in 2004-05 under the system. NGOs on the other hand, were involved in demonstrations and vigorous experimentation with use of bio-pesticides and other formulations using locally available ingredients and knowledge. These groups, as mentioned earlier see SRI quite differently from the government's own SRI which regard see as being excessively dependent on chemical fertilisers.

In Andhra Pradesh, the last two years have seen a rapid spread, largely due to the efforts of ANGRAU and the leadership of its then Director of Extension, Alapati Satyanarayana.

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[9] 'Pondicherry promotes new rice cultivation technology'. The Hindu. 12 August, 2004. http://www.thehindu.com/2004/08/12/stories/2004081204440300.htm

[10] See http://www.cicd-volunteerinafrica.org/files/post-tsunami%20prog.pdf for more details.

[11] These organisations included Centre for Indigenous Knowledge Systems (CIKS) -Sirkazhi in Nagapattinam and Tanjore districts; LEISA network in Trichy and Pudukottai districts; AME Foundation in Trichy district; VOICE Trust in Trichy and Perambalur districts and MSSRF in Pondicherry Ekoventure in Villupuram, Cuddalore, Kanchipuram and Tiruvallur districts.

A feature of SRI in AP is that it has been carried out in all districts of the state across several regions and has brought out several interesting results on SRI both in India and abroad. The highest yields or 17.2 tonnes per hectare have been reported by a farmer as also the largest extent of SRI by N V R K Raju in over 100 acres, a phenomenon not witnessed anywhere in the world. The AP results have also shown SRI maturing earlier than the conventional, crops withstanding lodging (even surviving cyclone) and indications that millers were realising the better quality of the crop and willing in some instances to pay more. The results also showed that the yield increase was more in the drier regions of the state, thereby allowing for more focused interventions.

WWF Dialogue Project and SRI

Andhra Pradesh has also had the very interesting instance of a unique kind of partnership between state and civil society that has shown a lot of promise and seems to indicate the way towards changing the institutional landscape of SRI. The WWF dialogue project (Dialogue on Water, Food and Environment based at ICRISAT, Patancheru) had after-discussions with ANGRAU and visiting farmers' fields taken up SRI in a big way supporting trials of 250 farmers in Rabi 2004-05 with an objective of evaluating SRI methodology for its potential to save water and increase productivity in different agro-climatic and irrigation sources. The partnership has not only allowed for a greater focus on assessing the methodology in the arid and semi-arid regions of the state but importantly, also broadened the scope of SRI studies in AP and India. The water-saving options for farmers were sought to be evaluated systematically and potential players like ICRISAT and IWMI have been roped in to bring their expertise to SRI. This is notable, for most CGIAR centres have been rather lukewarm to SRI. The project supported two intermediary agriculture support civil society organisations WASSAN (Watershed Support Services and Activities Network) and CSA (Centre for Sustainable Agriculture) to address the sociological dimensions in adoption of the method. The project has also supported a comparative soil biology/ micro-biology studies in SRI and non-SRI fields' by a senior soil biologist, O P Rupela from ICRISAT. The project has also made greater effort to place SRI within the larger farming community, organised farmer-to-farmer dialogues on SRI and has brought in greater participation from civil society actors.

What initially started off as an attempt to evaluate the water-saving potential in one of the seasons has now become into a comprehensive assessment of SRI involving many stakeholders. The project has continued in Kharif 2006 with a spread in more areas (coverage so far includes about 700, 11 districts, 6 rice research stations) but importantly, having civil society organisations working in collaboration with the infrastructure available at the university. A booklet on SRI has been produced by WASSAN with the financial support from the project drawing upon SRI experiences from a wider set that includes farmers' experiences and researchers and innovators who have been documenting SRI. The effort

is notable for the manual has gone beyond earlier manuals that have often relied only on the efforts of the agricultural department or university trials.

Yet another interesting initiative was to have a dialogue on technical improvements such as markers and weeders that hitherto was completely done by ANGRAU's engineering wing. The work by ANGRAU has been commendable in supplying weeders to farmers keen to take on SRI. However, the standardisation of designs has posed a few problems for farmers with diverse soil conditions in the state. During the spread of SRI, field-based groups realised difficulties with the weeders, especially in clayey soils. The technical dialogue facilitated by the project ensured greater receptiveness to user experiences and also sought to draw upon innovations from a wider set of formal and tacit knowledge. Following the workshop, newer weeders and markers were designed and applied by farmers in the cropping season.[12]

Apart from interventions and broad-basing the field-based spread of SRI, the WWF project has played an important role in influencing policy makers in the state of Andhra Pradesh and engaging the scientific establishment in India and world wide. Two events organised in November 2005 in Andhra Pradesh and March 2006 at the Philippines bring out this dimension very strongly.

The visit of the Chief Minister and Agriculture Minister organised by the project to the field of G Nagaratnam Naidu on 15 November, 2005 created a favourable policy environment in the state. The Chief Minister announced a Rs. 4-crore package for SRI for that Rabi season. There was also discussion on the water-saving potential of SRI and farmers experiences in adopting SRI method under different sources like open/bore wells, tanks and canal areas. The government was in the process of revising its free power policy for Rabi in those areas where the incentive was leading to a depletion of groundwater in many places. Suggestions on linking SRI practice in Rabi with the free electricity scheme were discussed. The combined presence of the state university research and extension staff, civil society organisations and farmers did leave a favourable impression with the minister.

The WWF project has also been conducting scientific tests based on the principles of SRI. With the involvement of Dr. O P Rupela, the soil microbiologist at ICRISAT, the project has been able to enthuse research staff of the Directorate of Rice Research (DoRR) to undertake trial plots on station at ICRISAT to enable detailed investigation of some of the microbiological and other parameters that enable or aid the growth of rice plants in SRI. The interesting aspect of the evaluation is the multidisciplinary team in place. This includes a scientist from crop improvement, an agronomist, an entomologist, a soil scientist and an agricultural extension scientist. Such multidisciplinary teams of scientists do indeed hold

[12] For details on the SRI manual and weeder and marker designs see www.wassan.org/sri . This site is the best current resource on SRI in India even though the activities of the organisation are predominantly in Andhra Pradesh.

a lot of prospects for SRI evaluation. The failure of such teams in investigations conducted has led to early rejection by rice scientists in the past in many parts of the world. The energy and enthusiasm of the DoRR scientists has culminated through the project into a national workshop in SRI to be held in November 2006, a significant event in the history of SRI in India. The conference format, unlike purely technical conferences has the involvement of farmers and civil society groups as well.[13]

Emboldened by the results of SRI in Andhra Pradesh and based on the ability to engage the scientific establishment, the WWF project team moved further by initiating an international dialogue on rice and water at the International Rice Research Institute in Manila. The conference, with the subtitle 'exploring options for food security and sustainable environments' was aimed at presenting SRI as a credible and legitimate option for food security and worth investing in. The meeting is significant for the IRRI and some of its scientists have been at the forefront of opposition of SRI (see Appendix 2 for a chronology of resistance). This important event co-hosted with IRRI, ICRISAT, FAO, Phil Rice, and the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) was meant to further the dialogue on SRI as a serious contender for future rice production, a prospect consistently ignored by the rice research establishment. The importance of saving of water through SRI in the context of the looming water crisis that has led to serious water conflicts was highlighted as also the ecological impact of biodiversity conservation and reduced pesticide and fertilizer use.

The role of newer actors and their contribution to institutional change is discussed later in the report. Suffice it is to say that the placing of SRI through the, WWF project has happened at three levels. Farmer innovations and incorporation of farmers experiences and difficulties into the research agenda, involvement of civil society groups, backing scientific investigation of SRI, placing SRI in the context of the water crisis as well as moving governmental and other players to modify policy to provide the necessary investments that could provide a fillip to innovations such as SRI have been the important contributions of the project.

SRI in Other States

In recent times SRI activity has spread to states other than Andhra Pradesh, Tamil Nadu, Karnataka, West Bengal and Pondicherry. Research activity was reported in the state of Gujarat by the rice research station in 2004. SRI activities have largely been due to the initiative of a few committed individuals from the agriculture department in states like Kerala in the south and Tripura in the North East. In both these states the officers concerned have pushed the agenda in the government, creating space for local training

[13] For more information see the WWF project dialogue bulletins http://www.iwmi.cgiar.org/dialogue/godavari/files/Jan06-Bulletin-Final.pdf and http://www.iwmi.cgiar.org/dialogue/godavari/files/DialogbulletinApril06.pdf

and dissemination. In the state of Kerala the Krishi Vigyan Kendra (KVK) at Mitraniketan has trained over 1000 farmers with guidance from T M Thiagarajan from neighbouring Tamil Nadu.[14] In Tripura the government has included SRI in its plan for self-sufficiency in rice and the Tripura Government buys SRI seeds from private farms at Rs 10 per kg (Rs. 8 for cost plus Rs. 2 as bonus) and sells it to growers at Rs. 14 per kg. A Roy Choudhury of the department of agriculture has been spearheading the SRI work there and has brought out manuals with the history of SRI (Devarajan 2005).

There is evidence that SRI was tried by groups in Maharashtra by the Academy of Development Studies, who however, do not seem to have got good results in the tribal pockets where the experiments were carried out. Chattisgarh in central India is known for its rice varieties and farmers have been keen to try out SRI. Jacob Nelliathanam, a farmer who has been keen on promoting Richharia's work in saving germplasm of the region and is working with traditional varieties, sees in SRI a boon for farmers growing these varieties that have a great role in conservation of biodiversity, apart from having interesting quality characteristics such as aroma. He has been practising SRI since 2003 and has encouraged farmers in Bilaspur (Kota and Larmi blocks), Chhapra (Sakti block), Durg (Balore) and Bastar (Kondagaon). The average yield through SRI has been from 8-10 quintals per acre with the best potential expressed in some cases of 20. All results have been well above the state average and these results have been on traditional varieties of rice and using no chemical fertilisers.

In Orissa, two NGOs have been spreading SRI in different parts of the state— Sambhav in eastern and southern Orissa and PRADAN in northern Orissa. PRADAN has used the work at Purulia and has organised exposure visits of farmers from Karanjia and Mayurbhanj. Sambhav had invited Nagaratnam Naidu, a successful organic farmer and with support from the Centre for Sustainable Agriculture (CSA) organised training camps for farmers which NGOs from eleven districts attended. There are interesting stories of how a farmer from Ganjam district went to neighbouring Andhra Pradesh to learn about SRI. The work in Orissa has a lot of promise though there is no government support to the ongoing work of the two NGOs. Like in many other states, manuals in local languages have been published. A farmer from Punjab took to SRI as early as 2001, following descriptions of SRI in the Cornell annual report of 1998-99 where SRI was mentioned. Work in the state on SRI has been low largely due to the stiff opposition from government officials and researchers of the region. However there have been some attempts by farmers in the region to practise SRI.

The above narrative provides a flavour of the complex evolution of SRI in India and the large number of diverse actors. In the following section we hope to situate the various actors in the emerging system of innovation with a view to appreciating the linkages between them. Using the innovation systems framework, we seek to draw upon some of the challenges for SRI in the years to come.

[14] See http://ciifad.cornell.edu/sri/countries/india/keralarpt.html for details on the Kerala work.

Innovation Systems and SRI

Recent insights in to the process of innovation in agriculture recognise that innovation involves not only research, but also a wide range of other activities, actors and relationships associated with the creation and transmission of knowledge and its productive use. As a framework for applying these insights the concept of an innovation system is emerging as a potentially valuable tool to help rethink the role and contribution of agricultural research (Hall et al 2004). Such concepts assume importance largely as a response to the limited explanatory power of conventional economic models that view innovation as a linear process driven by the supply of research and development (R&D). Instead the innovation systems framework helps conceptualise innovation in more systemic, interactive and evolutionary terms whereby networks of organisations and individuals and the pattern of interaction amongst actors assume greater importance in bringing about socio-economic change.

This approach has significance in understanding SRI. An SRI session organised by IWMI TATA at the Institute for Rural Management, Anand (IRMA) in 2005 was important as it was the first event which brought together researchers from different parts of the country to discuss SRI. However, the framing of the debate was in narrow economic terms and seems to have been influenced by the terms of discourse on 'rice wars' the previous year. The call for a conference paper was seeking field evidence to set to rest a debate. 'Claims and counter claims obfuscate the discussion on the performance of the much-hyped Madagascar technology of rice cultivation. Can it really revolutionise rice cultivation in South Asia?' The later programme schedule used the experiences of SRI by one of IWMI TATA partners in Purulia and the study but framed the question thus, 'If these claims are true, SRI can act as a broad-spectrum medicine against many ills that bewitch Indian agriculture, including poverty, low productivity, water scarcity….. But claims about SRI's benefits are questioned by many, including scientists from IRRI, world's leader in rice research.'[15]

Clearly the assumption underlying the assessment of the prospects of SRI seemed to be that detailed field estimates could prove or counter-prove these claims. We later show how

[15] See http://www.saciwaters.org/4thIWMItata%20annual%20partnersmeet.doc for details and programme schedule distributed at the conference.

such assumptions are facile and how the SRI actors actually provide multiple meanings to their work (also see Shambu Prasad et al. 2005). Greater insight in the future of SRI can be had by a closer examination of the actors and their interaction patterns. The innovation systems framework has actors placed under four broad domains – research, enterprise, demand and intermediary. In an evolving system such as SRI, a strict categorisation is not helpful, especially because actors such as farmers have multiple roles. Farmers are extensionists and researchers apart from being users of knowledge. So too NGOs, normally in the intermediary domain, were often in the forefront of research. Thus for the purpose of analysis of innovation as a process we look at the sector under two broad categories, the first being the formal agricultural establishment and the second civil society, much includes farmers. Appendix 3 has the list of the various research and non-research actors with a brief description on their SRI connection. Here we look at them closely.

SRI and the Agricultural Establishment: Extension-led Research

India has a rather extensive network of rice research centres that have been classified for convenience on the types of rice. The largest of these, the Directorate of Rice Research (DoRR) based at Hyderabad looks after issues related to irrigated and hybrid rice, while the Central Rice Research Institute (CRRI) at Cuttack looks after rainfed rice. There are other centres that specialise in Boro rice and Basmati rice. The approach of the rice research establishment thus has had a variety focus and is geared towards undertaking multi location trials and encouraging farmers to cultivate new varieties through extension systems. SRI on the contrary, is variety independent and is not based on yield enhancement through varietal change. Confronted with a different system the research establishment's response to SRI has been unenthusiastic. In fact one of the earliest PhD work on SRI was from the Water Technology Centre of the Indian Agricultural Research Institute (IARI) that looked at different establishment techniques, including SRI, on crop-water relationships in rice and on the yield of wheat in rotational rice-wheat cropping systems. The initial research design of the trials were originally planned to include one set of plots with 10-day-old seedlings. But this part of the research design was vetoed by agronomists on the IARI research committee; they allowed the trials to include only 15-day, 20-day and 25-day seedlings, insisting that 10-day-old seedlings were not worth even evaluating.[16] Yet, transplanting 10-day-old saplings is quite common in SRI.

On the contrary some of the more insightful research on SRI has emerged from the extension departments and not the research wings. The Indian NARS, like in most other countries, has a division between research and extension, the latter often having to take on the research done by the scientists. Extension is seen as not having any insights in the process of research except for providing 'user feedback'. On the contrary, SRI has been an interesting case where extension scientists have taken a lead in researching SRI. Alapati

[16] See Trip report of Uphoff to Tamil Nadu and Delhi, September 2003, pp. 7–9. http://ciifad.cornell.edu/sri/countries/india/tntrep03.pdf

Satyanarayana, head of the extension department of ANGRAU until recently, and not a rice researcher, has been at the forefront in providing insights into the early maturity of SRI crops, its pest resistance, milling outturn, etc. In Andhra Pradesh, the extension officers, notably the Krishi Vigyan Kendra at Undi, West Godavari, have carried out detailed evaluations on spacing and transplanting options for farmers. Recently ANGRAU have also initiated trials on SRI techniques to other crops such as ragi (finger millet).[17]

The initial reluctance of the formal rice research establishment in the SRI scenario is not unique to India; and has followed but similar trends of non acceptance of SRI from the formal research establishment in most parts of the world (see Appendix 2). As reported earlier, there has been a significant change in recent years of researchers from DoRR who have formed multidisciplinary teams to work with other actors and examine the prospects of SRI. DoRR is also hosting a big nationwide seminar in November on SRI with support from WWF. SRI is a case where a review of scientific practice is in order, a practice that is less dependent on inputs but is knowledge intensive. The former arose from the linear model of innovation following the Green Revolution. However the paradigm for SRI is knowledge or skill based. It has followed an alternate tradition of research where the relation between scientists and farmers have not been hierarchical and knowledge flow unidirectional. Some scientists who have been sensitive to the principles of SRI, have picked up insights from farmers fields, incorporated them in their research design and in the process added to the stock of knowledge on SRI and rice cultivation worldwide. Non-research actors have played an important role in the spread of SRI.

Non-research Actors in SRI

For ease of analysis, the non-research actors have been classified under the broad categories of SRI innovators, networks or groups, organisations (usually NGOs), and others (refer to Appendix 3). The last set includes training organisations, media and some 'enablers' or 'connectors' who often have a critical one-time role.[18] The list, however, is not complete for it was not possible to list all the farmers who are probably the most important part of the system. They have not been included as they are far too numerous even in our own list of farmers contacted in the southern states and Jharkand. Appendix 3 is thus not exhaustive but meant as an aid for analysis to indicate the types of players in the SRI innovation system.

SRI in India has often been made possible by a small group of SRI innovators who have dared to experiment with an untested system of practices. This category often involves several farmers who experiment and innovate. However, not all are from the

[17] There has since been a change in the perception of ICAR on SRI witnessed by its recent recommendation of SRI for the kharif season of 2005.

[18] See Gladwell 2000, who illustrates the role of the connector in his best-selling 'Tipping Point: How Little Things Can Make a Big Difference.

farming community; these experimenters also include people who have spent time as professionals in medicine, software industry, etc. The approach of these SRI innovators has been to try it out, making innovations on their own and in trial plots, and then using these experiences to have a farmer-to-farmer exchange. In fact, Premaratna, the SRI organic farmer in Sri Lanka whose efforts have promoted SRI among fellow farmers in Sri Lanka and elsewhere, has, it is estimated, trained over 4000 farmers without special funding. Some of these innovators play the role of researchers by searching the Internet for information and passing it on to farmers and writing about it in their network journals or through separate publications.[19]

Networks and organisations have played an important part in the spread, of SRI. These networks include farmers' organisations such as Kisan Forum or Water Users Associations or formal ones of NGOs like the LEISA Network who have rallied around the issue of organic farming or water management (Jalaspandana). Some of these networks have served no more than provide useful social capital. The social capital of Cornell University alumnus is a very good example of how networks facilitate important processes and innovations. In this case they facilitated key meetings with officials and in some cases just played the role of transferring information to organisations such as PRADAN. The existence of prior farmer organisations often aids the spread of ideas and is possibly one of the reasons for the difference in adoption levels across India with these networks more active in the south than the north of India. These networks are often knit informally and are not exclusive, so it is not surprising to find members of the first group playing different roles in the networks.

The third set of non research actors are formal organisations, both non-governmental, governmental and private. Of these the last mentioned has not been very much in the system though there has been interest by seed companies in Andhra Pradesh. Some private companies making bio pesticides have taken to SRI, but it is not clear if these are out of personal or corporate interest. Government agencies rely on the existing government machinery of extension agencies and line departments. However, in many states given the slow response of the department of agriculture, the line departments have not been fully involved in spread of SRI. In Andhra Pradesh it is the network of extension agencies of the ANGRAU that has been very proactive, while in Tamil Nadu targets for the Cauvery basin have driven agricultural officials to promote SRI. There is evidence that departments of agriculture are now evincing interest in states such as Karnataka. Amongst government agencies in states like Andhra Pradesh, Karnataka and Pondicherry, the irrigation departments have shown a lot of interest. In fact they have led SRI in the latter two states while in Andhra Pradesh the scale of operation of the irrigation department is set to exceed the agriculture and university targets on SRI.

[19] Santosh Kouligi's booklet titled 'Battada Bele - Madagascar Vidhaana' in Kannada in 2002 has sold nearly 2000 copies.

Formal civil society organisations have played a prominent role in the SRI innovation system in India. The extent of involvement and even the nature has been varied amongst the states, and even within states. Some organisations have of course been isolated and concentrated on perfecting SRI as a system in their region locally, while others have been keen to promote SRI to more farmers even as they undertake their own activities. A few others like the WWF dialogue project have worked at the policy level and have incorporated big stakeholders such as ANGRAU and other civil society organisations. The contribution of civil society is not only in the spread of SRI but also in shaping the debates, in situating SRI within a broader canvas of sustainable agriculture, farmers' innovation, a focus on less privileged areas and in many cases a deliberate pro-poor focus.

The final category of actors of the SRI innovation system in India is the print and electronic media. Here is a case where the vernacular media has followed and promoted SRI vigorously whilst the more popular English language media has not been very active if not indifferent in some instances. The media can play a positive and negative role. Popular agricultural journals in regional media such as Annadata, and regional television channels have all been used by SRI practitioners in accessing and disseminating information. Overall the proponents of SRI have used the print and electronic media effectively in the vernacular. We followed articles on SRI in the East Godavari district of Andhra Pradesh in 2003 and 2004. There were no less than 69 news items on SRI in 2003 from July when the crop was first introduced in the region. These articles reported the new system and farmers' perceptions of it.[20] Apart from getting news items many groups have brought out their own publications, pamphlets, video films and CDs on SRI. The Internet has also been used to good effect by a few NGOs and farmers involved in sustainable development, and they have found the information on the web on SRI to be useful and encouraging enough to try out SRI on their own.

There have been instances of serious misrepresentations by the media with even a popular newspaper like The Hindu which has carried several news items on SRI, for instance a piece that described SRI as an invention by the International Rice Research Institute, ignoring even the claims of agricultural researchers such as Thiyagarajan and Satyanarayana, not to speak of farmers such as Ramaswamy Selvam and Narayana Reddy who actually took to SRI earlier than most and surely not from IRRI.[21] Another media report called SRI a magic potion.

The extent of linkage between actors and organisations is weak in some states like Tamil Nadu, where almost two different systems of SRI are in place by state and civil society.

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[20] The following year the number of articles decreased as it was no more new, yet there were 48 articles. Many of these articles were promoted actively by extension agents of the district. We are grateful to Shri B Jagadeeswara Rao of the Department of Agriculture for sharing these newspaper clippings with us.

[21] Agriculture Correspondent. 2005. Madagascar Technology: Proven method for boosting rice yields. The Hindu. 28 April 2005. http://www.thehindu.com/thehindu/seta/2005/04/28/stories/2005042801071900.htm

Linkages between the research and non-research actors are missing right now – similarly, the link between non-research actors and policy makers as well to give more thrust to organic farming through SRI. There is not sufficient two-way flow of information between farmers and researchers in the system currently. This can hinder innovations and lead to rigidities. On the contrary, in Andhra Pradesh there has recently been good experience of collaborative work. However, it would be true to state that in many cases actors do not seem to be aware of each others' activities. This has emerged several times during the research study. Often the facilitator links or actors who bring together various domains and actors seem to be missing. Greater opportunities for interaction and learning can enable this. There are also insufficient horizontal linkages between farmers and researchers across regions with immense possibilities of cross-learning.

SRI and Rural Innovation: Summary, Insights and Implications

SRI in India is a continually evolving and dynamic system with new actors entering the system in every agricultural season. SRI in India was initially assumed to have originated from research trials at the agricultural universities. This study has however revealed that there is a richer and more complex unofficial history of SRI in India that shows' a greater involvement of civil society groups who though not successful initially, were at the forefront of experimentation. They created a culture of innovation that enabled greater governmental intervention in later years.

An important feature of SRI in India is that it has no uniform characteristic nor any single agency or organisation driving it. It has been carried out by both government agencies and civil society with a varying combination of collaboration amongst them in the regions. In fact it might even appear that speaking of a national system of SRI innovation is a misnomer, with each state and region showing very distinct and diverse characteristics. There is no single SRI in India, SRI actually involves diverse practices of the basic principles and farmers and other actors in the system have adopted it to mean different things. They have extended it by providing diverse interpretations, even within the formal scientific establishment.

Leading states such as Tamil Nadu and Andhra Pradesh, through their agricultural extension wings have started producing manuals on SRI for its popularisation, after initiative was taken by a few innovative leaders at TNAU and ANGRAU. However, there is a lot of diversity even amongst them. The work in Tamil Nadu is concentrated in the Cauvery basin where the state government has decided to cover 25% of cropped area through SRI. In Andhra, on the other hand, the work is being undertaken in all the districts and agro-ecological regions. There are differences in the technical practices too, as a closer look at the manuals would indicate. The emphasis on organic modes of production is more in Andhra Pradesh, whereas Tamil Nadu extension agencies recommend use of an LCC (Leaf Colour Card) to enable farmers to apply fertilisers at regular intervals based on a comparison and standardisation of rice fields in the laboratory and the farmers' fields.

The biggest source of diversity, though, is in farmers' fields where individual farmers have adapted SRI to what they think is best in their region or farm. The diversity is apparent in terms of varieties being used for cultivation, spacing patterns between rows, weeder and marker types, use of organic manure or bio pesticides, irrigated or rainfed usage, mix of chemical and organic content, etc. Over and above these are the diversity in organisational groupings and networks, names used to describe SRI, the leaders or key actors in each region and so on.

Overall significant new knowledge has been added by SRI actors in India to the global SRI innovation system in terms of applying the SRI principles across large areas and proving SRI not to be a niche invention, pointing to its advantages in arid and semi-arid regions that missed out on the Green Revolution and particularities of pest resistance and soil microbial activity (Satyanarayana 2005, Punna Rao and Satyanarayana 2005). So far there has been no comprehensive estimate of SRI performance even in a single state. An informed guess would place Andhra Pradesh as a leader both in terms of results (largest extent of 100 acres by NVRK Raju, or yield of 17.2 t/ha by S L Reddy), number of farmers (estimated at over 10000 in Kharif 2004), number of demonstration trials (over 800) and trainings and coverage of all 23 districts (Satyanarayana 2004, Punna Rao and Satyanarayana 2005).

However such a comparison would not be apt for SRI. The performance needs to be viewed in the context of diverse applications in each state. The pro-poor element has been higher in West Bengal and Jharkand, with SRI benefiting largely poor small and marginal farmers, while in states like Andhra Pradesh, there has been no explicit pro-poor focus in extension of SRI by the state. Tamil Nadu has assigned targets of 100000 acres for SRI for the year 2004-2005 and similar targets have now been taken up by irrigation departments of Andhra Pradesh that choose to cover 100,000 acres this kharif though 1000 master farmers. Farmers and researchers have reported yield increase through SRI of 1.5 – 2.54 t/ha in Tamil Nadu and Andhra Pradesh (Satyanarayana 2004, Thiyagarajan et al. 2005,), a saving in water, an increase in straw yield by 50%, Labour productivity increased by 43%, with net returns increase by 67% in the IWMI TATA study in Purulia (S. K. Sinha and J Talati, 2005). Research has begun on extending SRI principles to other crops like ragi (finger millet) and to greater use of traditional varieties.

There are four broad areas on which SRI has implications for pro-poor innovation. These are

1. Enabling grassroots innovation
2. Providing greater choice
3. Insights on the generation and use of new knowledge
4. Broader implications for agricultural research.

SRI as Enabling Grassroots Innovation

Field experiences reveal that SRI has unravelled the innovation capacity of farmers and civil society. Farmer innovations have been quite extensive in SRI in tools such as markers and weeders and in practices of spacing, use of composts and bio pesticides and local adaptations. For example, Gopal has adapted SRI with a system of double transplantation (from primary bed to secondary bed and then to the main fields) of rice plants, but as single seedlings and not as clumps of 2–5 seedlings. This system, now popular as the Kadiramangalam system of rice intensification, seems well suited to the Cauvery delta zone with advantages of zero mortality of seedlings and lesser weeding problem. This system has become popular among farmers who are now buying the seedlings and practising SRI without changing their practices as drastically as SRI requires. Gopal has also experimented with wider spacing in cotton.

Narayana Reddy of Dodballapur, Karnataka, a reputed organic farmer, is one of the earliest to have experimented with SRI. He heard about it in 2001 and started practising it soon after. However, the transplantation of 10–15-day seedlings bothered him, and he decided to follow his wife's suggestion and broadcast the seeds directly after pre-germinating them. He also modified practices of ploughing and chose a traditional weeder that was being used for other crops like groundnut and maize, which he felt could be used to good effect without buying the more expensive conoweeder. Narayana Reddy travels extensively, now, promoting SRI which he considers to be the 'innovation of his lifetime' in his 30 years experience as a farmer. He has also encouraged farmers to use drip and sprinklers to grow rice! Reddy's friends Mrtyunjayappa and Appaswamy innovated by using traditional varieties, jeeraga samba and haalubbalu which they treated further in cow's milk or neem and karineki leaves before sowing.

Santosh Kouligi, another organic farmer in Melkote of Karnataka, also does direct seeding though he uses untreated seed, and a traditional wooden tool called 'gentu' with teeth at 30 cm spacing is used to mark the field in both directions.[22] Sappe Sriramamurthy of East Godavari district in Andhra Pradesh has 'invented' a marker that has made the transplantation process easier. The extension department has adopted this marker and is popularising this. There are also several farmers who have been using different spacing options and trying to work out local optimums. In almost all the cases, there is learning associated with each SRI crop or trial. Brajamohan, a farmer

[22] Both Narayana Reddy and Santosh Kouligi write about their work. Reddy has a column in the LEISA newsletter, while Kouligi authored a popular 16-page booklet in Kannada on SRI entitled ;Battada Bele - Madagascar Vidhaana'.

in Jharkand (where weeders are not used, unlike in south India) developed a unique hand weeder to loosen soil and weeding operations. For Srirammurthy, Narayana Reddy, Gopal and so many farmers, SRI as a system seems to have provided an outlet for their hidden innovative abilities. Noticeably, the learning cycles have been very short and often within a crop period.

Innovation is about Providing Greater Choice and Multiple Meanings

For many farmers especially in dryland areas its experimentation potential and the sheer possibility of having a rice crop with SRI principles have attracted them more than its ability to achieve 'super yields'. Rice is a very important staple and preferred crop of poor farmers but often they are consumers alone due to lack of access to irrigation water. SRI seems to offer a potential to expand the base of producers and regions and provide better opportunities for poor farmers, in dryland areas (see Box 2 for the experience of Timbaktu Collective in providing farmers' added choice through SRI).

Box 2: Growing Rice in Drylands: Civil Society Innovation Using SRI

Farmers in Mustikovila of Chennekottapalli Mandal of Anantapur district had in the past organised themselves with help from the Timbaktu Collective to desilt and repair a traditional tank in their area. This became their main source of irrigation in the chronically drought-affected Anantapur district. Over 500 farmers in tank-irrigated Mustikovila and adjoining villages in Rabi 2003, had prepared their land and were misled by rains that lasted only three days, forcing the local administration to close the sluice gates. Keen to save their crop, the farmers approached the local MLA, but they were warned there would be no compensation in case of crop failure. Through the Timbaktu Collective some of the farmers had been to Narayana Reddy's farm to learn about paddy cultivation without flooding; Reddy later visited and advised them. One of the earliest to have experimented with SRI, Reddy considers SRI to be the 'innovation of his lifetime'. The farmers and the Collective got together and decided to have a strict monitoring and regulation of water use, with water released just once in five days, and were able to save their crop. That year Mustikovila was the largest patch of land (over 370 acres) with a rice crop in the district, through the application of one, not all, of SRI principles. SRI here was not about getting higher yields than a conventional plot, but more about allowing farmers to mitigate risk and re-establish control over resources. This benefited farmers who, over the years, had become increasingly dependent on and vulnerable to external agencies. SRI rice was not seen as an end in itself but as means to greater food self-sufficiency and resource conservation in the region. The Collective has since carried on its SRI work, offering technical expertise to farmers in their region who have been taking up SRI.

The pro-poor focus of innovation in SRI is often not obvious except in places like Purulia where it has offered small and marginal farmers increased incomes. Its contribution to poverty is more in its potential to reverse the negative trends of the Green Revolution that had concentrated rice production to a few places and with limited varieties and with dependence on high inputs. This potential of sustainable production and increased choices for farmers is what makes it attractive to many. Several farmers who have traditionally been growing rice for centuries and have conserved traditional varieties now have in SRI the possibility of increased yields and greater marketability of their crop, a choice that was open to few in recent times. This potential is yet to be tapped but civil society organisations working in the area of biodiversity conservation have seen in SRI this possibility of increased choices.

An advantage of SRI not being a rigid technological practice but a system of principles that needs adaptation has allowed for experimentation and adaptation. SRI has meant different things to different stakeholders and actors. An official understanding of SRI as a technique is inadequate to capture the diverse meanings that farmers and other actors have and are continuing to give SRI.

Insights into the Generation and Use of New Knowledge

SRI reiterates and illustrates some of the insights on innovation and new knowledge. The first being the multiple sources of knowledge (Biggs 1990). The innovation occurred largely in farmers' fields and the key players were civil society SRI innovators and their networks. These sources of innovation are important and need to be seen as integral to the innovation system by the government and scientists, even as the case suggests, they challenge existing paradigms of research. SRI is a case where each actor has accessed new knowledge from several sources – fellow farmers, researchers, networks, and the Internet. SRI is also a case where there has not been great separation between access of knowledge, its use and generation. Often these have been simultaneous processes. For example, farmers like Narayana Reddy and Kouligi have accessed new knowledge even as they were experimenting with it and disseminating it. New knowledge is enabled by better knowledge flows amongst actors (see Box 3 for the 'discovery' of rice not being an aquatic plant by Raju).

Innovation in Process and Tacit Knowledge

The SRI case study shows the importance of process innovations. It is primarily a system with principles for application and customisation on farmers' fields. It is not a new technology that is invariant to the user of the technology. Tacit knowledge of farmers and civil society researchers played a critical role in SRI especially in the early stage and its take off. The absence of easy codification was a barrier for research establishments to look at SRI in the early stages. The few researchers who took to SRI, had to make sense of this tacit knowledge especially as it was counter-intuitive and seemed to go against received

Box 3: Rice Not an Aquatic Plant: Explaining Farmers' Innovation

The story of Jagga Raju from Dirusumaru village of West Godavari district of Andhra Pradesh is a case in point. He was known in the area for multiplication of seeds, and many farmers buy seeds from him or request him to multiply. The nearby Krishi Vigyan Kendra (KVK) at Undi was experimenting with a new improved variety of rice (MTU 1071, now very popular among SRI farmers) and approached Jagga Raju for its multiplication in the year 2000. Raju had a wider interest in farming and gardening and experimented with the variety by placing rice seeds in potted plants and in raised beds. The plants grew with profuse tillering (over 150 tillers) and those that were grown in potted plants as single seeds had tillers of 200 and above. Jagga Raju had not heard about SRI or the Madagascar method. Empirically, however, he had proved that rice was not an aquatic plant. The training officer of the KVK often took the potted plants for demonstration purposes. Alapati Satyanarayana had seen these plants and did not believe that they were from single seeds; however, when he was exposed to SRI subsequently, he was able to make the connection. SRI in this case 'explained' a farmer innovation and could be a system built on it. Importantly, it also seems to offer insights into an emerging innovation process in the rice fields of South Asia wherein the interaction between the research and extension staff with farmers is not seen as a one-way street but as a process with strong feedback loops which can collectively contribute to the knowledge pool.

codified knowledge in the research establishment (see Box 3). This is not to undermine the importance of codified knowledge but to point out that even for formal research an understanding of tacit knowledge is critical. Put differently, it could also mean valuing different knowledge systems and often using these to reflect, redirect and reframe one's own research.[23]

Knowledge in the Public Domain

One of the key features of the spread to SRI is the keenness of actors to place knowledge in the public domain. It allows farmers and civil society actors to access and improve the stock of knowledge. There are several cases wherein farmers looking for ways out have found the Internet, the SRI website of Cornell University and popular farmers' journals as providing important leads for their experiments.[24] In many cases, even though the knowledge was still

[23] The key principles of reflect, redirect and reframe are seen as critical to Institutional Learning And Change (ILAC). See www.cgiar-ilac.org

[24] The constantly updated website on SRI by Cornell in collaboration with ATS is the best place for comprehensive technical and social information on SRI and its spread in the world. The website has several research reports and the very informative trip reports of Norman Uphoff. The website has been used extensively in the study in building the timeline and following up field visits. See http://ciifad.cornell.edu/sri/ and for the India section http://ciifad.cornell.edu/sri/countries/india/index.html . Apart from the above there are now yahoo groups on SRI, none as yet for India but several SRI enthusiasts from India are members of the SRI Nepal yahoo group.

in process and not 'finished', sharing information and experiences has been critical to the spread of SRI. This common willingness to share is an attribute of many an SRI champion. Another recent instance of this is the SRI website of WASSAN, where weeder and market designs have been placed in public domain with a view to foster innovation.

Role of Networks

Actors in the innovation system of SRI have used their networks to very good effect in propagating and accessing knowledge. These networks of farmers, NGOs and researchers can be region-specific but as is often the case, actors in the networks are aligned to other actors through many networks and group, formally and informally. They also play different roles in these networks, a farmer often plays the role of extensionist or researcher in a network but at the same time can be member of an all-farmer network. The spread of SRI has been more in places where pre-existing networks of farmers and researchers exist. However, new networks are also in the process of being formed through SRI. A good way to understand innovation is often to look at these innovation networks.

Role of Champions

Innovations, especially with a pro-poor focus and those that challenge existing paradigms need champions who are willing to back the innovation and its system of actors even when there are no immediate takers. SRI in India has several such champions who have learnt about the innovation, practised and disseminated or championed it in different places and platforms and that too in a very short time (some SRI champions in India are Alapati Satyanarayana, T M Thiyagarajan, Narayana Reddy, Selvam Ramaswamy and Norman Uphoff). They have pushed for and brought about change amongst a large set of actors by talking and writing about SRI and constantly updating their understanding with new knowledge. Some of these champions are visible whereas there are others who see their roles differently by working on the system, by bringing out changes in practices of the actors and encouraging exchange of tacit and codified knowledge (Dwarakanath, Pushpalata, WWF Dialogue project organisers). What is often missing is the role of several champions who have played important roles in the spread of SRI in smaller states. Personal initiative, a good understanding of the system and a vision have seen many agricultural scientists try out SRI and push for it in the field even as their peers have ignored them.

Responding to External Triggers

External triggers such as drought have been a factor for farmers who are looking for systems that allow them to grow a crop with reduced water use. Ramaswamy Selvam, an organic farmer from Erode in Tamil Nadu, chose to try out SRI in 2000 when he first heard of it because farmers in the Lower Bhavani canal area had a drought-like condition with no irrigation water. Though not grown on an area as large as they normally would, trying

out SRI on a small area offered farmers like him an opportunity to have a rice crop. The yield in this case was not particularly high, although it did improve in subsequent years. The overriding reason for this farmer to go in for SRI was the possibility of having a rice crop at all. This has been the case for farmers taking to it in many of the delta or canal-irrigated areas, even though they may not necessarily practise SRI when assured irrigation exists. The following case of farmers in Anantapur district indicates how a civil society organisation — the Timbaktu Collective — turned a crisis into an opportunity by using SRI principles (see Box 2).

The Importance of Habits and Practices

Institutional settings play a central role in shaping the processes that are critical to innovation: interaction, learning and sharing knowledge. The innovation systems framework distinguishes institutions from organisations. Organisations are bodies such as enterprises, research institutes, farmer cooperatives and governmental or non-governmental organisations (NGOs), whilst institutions are the sets of common habits, routines, practices, rules or laws that regulate the relationships and interactions between individuals and groups (Edquist 1997). It is these habits and practices that facilitate knowledge flow amongst actors, which determine whether the benefit is widespread and has a poverty focus.

We have earlier seen how the habits and practices of research organisations hindered the work on SRI. Those researchers who did bring about change brought out institutional innovations by introducing new habits and practices such as encouraging extension staff to take up research or scientists (especially in Andhra Pradesh) spending more time at farmers' fields (Andhra Pradesh and Karnataka) or working with an NGO-funded activity (WWF ANGRAU project in Andhra Pradesh), choosing to learn from southern partners instead of the West (visit of Satyanarayana to Sri Lanka being an example). Institutional innovations have played an important role in the spread of SRI and these invariably involve changes in habits and practices of organisations, governmental or otherwise.

The lack of an explicit pro-poor focus in mandates of extension organisation seems to skew adopters in many instances towards bigger farmers by extension departments who they believe have the resources and capacity to innovate. Civil society organisations are better situated in this regard in that they seek to maintain a pro-poor focus and enhance farmers' and their capacity to innovate. Existing habits of mistrust between state agencies and civil society is a factor that has slowed learning opportunities. There have been few cases of partnerships with dissimilar actors such as the WWF dialogue project which shows the potential for institutional innovation and offers interesting insights on how to enable changes in habits and practices. Reluctant partners such as state agencies and civil society organisations have been forced in a sense to work together and there has

been increased trust and learning. Government agencies can consider such pro-active possibilities of getting research organisations to work in partnership mode at an early stage of their research with users of knowledge. SRI has different characteristics in each state and it would be instructive to explore the habits and practices of actors which can be used as a tool for planning.

Role of Civil Society

SRI originated in Madagascar as a civil society initiative and has in India owed a lot to civil society for its spread. Civil society groups have been at the forefront of experimentation, dissemination and have contributed significantly in bringing out several technical and institutional innovations. They have been able to add elements of pro-poor innovation and raised questions of sustainability and opportunities for small and marginal farmers. They have also extended the mandate of SRI to look into research possibilities with traditional varieties of rice and have brought a greater measure of accountability to the innovation system by initiating dialogue and being more open to reporting cases of failure and learning from them. Importantly, they have extended the meaning of SRI and interpreted it as a process and not just as a technology (see Box 2). In some cases like the WWF project, they have been able to attract the attention of researchers of international agricultural research centres and policy makers to look at SRI and engage with the questions that it raises on food security. They have seen the marginal increase in small farmers' fields of greater importance than achievement of super yields in a few big farmers' fields. Also, their practices indicate a broader set that includes improving soils, better systems for community management of scarce resources and farmer-to-farmer learning.

Policy Implications

Policies also influence the way people behave. An environment that supports or encourages innovation is not the outcome of a single policy but relies on a set of policies that work together to shape innovative behaviour. Though there are policies at the state level, some explicit and target oriented such as in Tamil Nadu and recently in Andhra Pradesh, there are no policy guidelines on SRI at the national level. The closest has been the recommendation to adopt SRI in some regions in Kharif 2005; however these do not have mechanisms laid out for implementation.[25] Policy support to SRI has been in the form of state-level input subsidies on weeders and markers in some states. In most others no policy exists to support SRI activity. Support structures have been weak in many places as the timely availability of SRI advice to farmers has not been facilitated, in many

[25] See press release of GoI, 31 May, 2005. http://pib.nic.in/release/release.asp?relid=9545

These policies begin to make sense only when government orders are issues by the departments for practice by field level staff or line departments of agriculture. An example is the GO (government order) No. SFPP(1) 288/2004, of the O/o Commissioner & Director of Agriculture, Andhra Pradesh that indicates what SRI is, what the government proposes to do and how the agencies concerned should do it. See http://www.gist.ap.nic.in/agri/192004/sri.html

cases leading to disadoption. Often line department officials are not knowledgeable on SRI. There is too much emphasis on SRI as a technology rather than as a set of principles for local innovation and customisation by farmers. SRI is skill and knowledge intensive and policy and support structures have not been adequately geared to building such a capacity.

This seems a crucial area for intervention. The public sector research agency by and large has been sceptical of SRI. Incentives do not exist to promote innovation, expertise in some instances of key personnel has been lost out of the sector due to lack of pro-active measures. The agriculture departments need to learn from their own experiences of functioning differently in SRI, so that the experiences can be extended to others. Recognition for enterprise of officials appears to be lacking. Mechanisms of sharing insights and learning do not seem to exist in good measure.

Public policy in agriculture can be contradictory; SRI is often promoted along with chemical or input-intensive agriculture often by the same staff. Placing SRI more firmly on government agenda might be one way of overcoming this. There has been some discussion with regard to the recent 'free power' scheme of the Government of Andhra Pradesh. The state is seeking to avoid subsidy on power for farmers growing rice in Rabi. A suggestion has been made that this could be done with a caveat that SRI farmers would get a relief on this for they would be saving on water and thereby power for pumping it. Such possibilities exist to provide for a supportive mechanism that will also increase demand for SRI. Overall, much needs to be done on the policy front both in the form of increased allocation but more importantly, in terms of fostering innovation.

Donor support to SRI has not been consistent, with few donors being willing to take the risk. Those that have, like the Government of Tamil Nadu which allocated huge targets for SRI adoption in the delta region, have not seen SRI as part of the larger innovation system but have done it in the conventional way of fixing targets and expecting the department of agriculture to work miracles. Such policies are unlikely to work effectively in knowledge-intensive areas like SRI. Donors would do well to create deliberate spaces for interaction amongst a wider set of actors and not just similar organisations, namely researchers discussing results amongst themselves and publishing the same or NGOs reporting results only to donor agencies.

The reason for certain actors taking to SRI and others not, needs to be understood more carefully. SRI has been a case where for instance irrigation departments and smaller states and organisations have been able to innovate better than bigger states such as Punjab, which is yet to figure on the SRI map of India. The response of organisations to external triggers seems to be a good opportunity to innovate and this ability needs to be capitalised.

Reconfiguring Agricultural Research: Biggest Challenge Facing SRI

SRI faces several challenges. It is a system that is still evolving and a case where the technology or practice has preceded the science of the system. While the reasons for SRI working are broadly known, the details still need to be worked out, and there is a strong case for scientific interest in the subject from the agricultural research community (national and international). Greater scientific inputs are necessary to appreciate soil microbial activity and the principles of SRI, which run counter to many ideas in rice science. The experience of SRI globally – and India is no exception – has been that scientists in rice research establishment, particularly plant breeders, have not been very keen on pursuing this new research agenda (partly owing to the 'rice wars', or rather the portrayal of SRI in it). However, scientists from other disciplines such as soil science, microbiology, entomology and farming systems have been able to look at SRI from a different point of view and are interested or are carrying out experiments to understand or clarify the phenomenon.

Field-level results continue to throw up several research questions that are in need of scientific understanding, if not validation. The possibilities of extending the SRI principles to other areas of research and other crops is indeed challenging, and it does appear that this is an area that has been relatively unexplored and is in need of attention by the scientific community.[26] By and large, the scientific community has been silent on the research experience of SRI. The format for collection of data on field trials by the agriculture department and university is heavily biased towards yield considerations. Other parameters that might be equally important, like water saving, ability to handle risk or vulnerability towards failure of bore wells, or qualitative parameters on rice plants, are not noted. Farmers, however, have several stories to tell about soil quality, fodder, pest incidence, maturity, grain size, etc, none of which seem to be monitored systematically.

One of the critical issues relating to SRI is its evaluation as a 'technology', which often assumes that claims and counter-claims can be verified objectively through field trials and experiments. Our empirical results, however, show that a much broader view is required on the choices made by user groups for or against a particular choice, not all of it based on yields or super-yields. While the latter seem to be the criteria for researchers as evident

[26] There has been some progress in terms of recent trials on Ragi by ANGRAU in one of their centres. Civil society organisations such as Green Foundation, Timbaktu Collective have tried it out with Ragi, jowar, castor, bajra and farmers with sugarcane and even cotton (Gopal).

in the debates surrounding the 'rice wars' of 2004, farmers and innovators often have other criteria for choosing SRI (see Shambu Prasad et al. 2005).[27] Learning, adaptation, innovation, diversity, and system – these seem to be the key words in SRI. All of these require a different framework for understanding a framework that goes beyond traditional understandings of 'transfer of technology'.

Reconfiguring agricultural research by far seems to be the greatest challenge if SRI and other pro-poor innovations are expected to make headway. In the traditional linear model on which most agricultural research is organised, there is thus a division of labour whereby public scientific bodies – seen as the primary source of new knowledge – are organised in a hierarchical structure with a linear flow of resources and information from the top to the bottom. One of the problems that this mindset encourages is the view that civil society should be located at the last stage of the innovation chain (extension activities), disseminating the innovations of others and not as contributing to invention. SRI challenges this view quite frontally. SRI in fact has been one of the most outstanding contributions of civil society – from farmers to the ATS to agricultural research and as the spread of SRI in India indicates, 'extension' has been ahead of 'research' in taking the innovation forward.

It is however being increasingly realised that assumptions of the conventional or linear model of innovation do not reflect the complex reality of technology development and innovation in the agriculture sector. Innovation is now understood as a process that involves linkages and feedback between the main actors (Clark et al. 2003); multiple sources of innovation (Biggs 1990); user adaptations (Douthwaite 2002); iterative processes of learning and reframing of approaches and research questions (Hall et al. 2004). A point often reiterated by Satyanarayana in talking about SRI is the difference between his work on SRI and his earlier work on improved varieties. Disseminating the latter was relatively simple, one had a new variety and the system was tuned to deliver it and reach it to the farmer. SRI, however, is skill- or knowledge intensive, and the same approach could not work. Dealing with complex systems requires a new framework that conventional economic evaluation tools do not provide.

This has implications for the way SRI is assessed. It allows for the possibility of assessing a system instead of a technology and helps reconfigure the debate by focusing on those linkages within the system that are weak and need strengthening or intervention. The basic

[27] A closer look at the writings on SRI indicates that SRI has been promoted more as a 'system' rather than a 'technology'. One of the earliest articles on SRI by Rabenandrasana (1999) suggests this broader view of how Association Tefy Saina (ATS) saw SRI. ;ATS insists that it be treated as an approach, a strategy, even a philosophy, rather than a 'package'. … These practices need to be tested and, if need be, adapted when introduced to new environments.' He further adds that 'by mobilising the experimental capacity of thousands of farmers to adapt the technology to different conditions, SRI could become one of the most beneficial innovations in agricultural practice this century'. Berkelaar (2001) echoes this when she states that "SRI should be seen not as a technology to be applied mechanistically, but rather as a methodology to be tested and adapted to farmers' conditions. Farmers need to be good observers and good learners to make the best use of the insights that SRI provides".

hypothesis of the framework is that the capacity to continuously innovate is a function of linkages, working practices (institutions) and policies that promote knowledge flows and learning among all organisations within a sector. Mapping the SRI innovation system that has been attempted here is one way forward. Working with some of the interesting features of the innovation system enables greater participation as this could highlight what the research community feels are issues that need to be addressed as part of the system rather than as external critics. There are indeed several features of SRI that can answer the criticisms of agricultural research, if observed closely. For instance, the exchange of information freely by researchers with farmers, and vice versa, is one of the positive aspects of SRI in India, a process that is rarely witnessed, despite talks of participatory research within the research community.

The issues raised by SRI are not something altogether new. Farmers and civil society have been at the forefront of raising issues concerning alternate conceptions of science, a cognitive element always ignored by the research establishment. They have also raised the need for a different way of looking at farming and the complexities that it entails. SRI needs to be seen by the research establishment as a dialogue point where it could contribute to newer agendas instead of criticising it from conventional viewpoints. It presents a challenge to the scientific community at several levels, even if it has to seek alternatives to verify data where synergy and complexity is part of the assessment, instead of conventional assessments that seek to attribute changes to just one factor, keeping other factors constant.

Recent thinking in agricultural research centres has pointed to the importance of 'institutional learning and change' (ILAC) as an explicit recognition that traditional transfer of technology approaches to agricultural research can no longer keep pace with the complex, diverse, risk-prone and dynamic situations faced by poor farmers. ILAC recognises that problem-solving agricultural research, by its very nature, is a risky enterprise. Outputs and outcomes cannot be predicted with certainty. It involves a degree of trial and error in which not all – and probably not even a majority of – research paths achieve their intended goals and positively affect the livelihoods of the poor. However, research centres need to foster a culture of innovation, learning and change (Watts et al. 2003). We believe that the prospects of SRI in revolutionising the lives of the poor are linked to the possibility of a similar revolution amongst research centres in reconfiguring themselves to meet newer challenges rather than sitting in judgement on a phenomenon by assessing a system based on field trials. While we do not underestimate the need for objective parameters on which SRI needs to be assessed, we argue that such an assessment needs to happen from a systemic point of view where actors in the system are properly understood and their alternative meanings of practice are incorporated. The present SRI assessments seem to fall short of this, and it might be worthwhile to include perspectives from a broader history and sociology of scientific practice.

SRI in India is not a single story with a single message, but several stories with interrelated messages. The Indian experience also reveals possibilities of reconfiguring agricultural research by looking at extension differently and also by showing how farmer– scientist interaction can be mutually enriching. The wide diversity of SRI practices and even names to describe SRI reveal interesting opportunities for farmers, agricultural scientists and government agencies to rework themselves in collaboration with civil society organisations, and there have been some very interesting cases of partnerships and lessons emerging from these in some of the more recent work on SRI. We have to add here that we are not suggesting that everything about SRI in India is perfect and the best model or that SRI has worked everywhere. In fact, what is interesting about the results of farmers trying out SRI by themselves or through civil society intervention is that not all of them have been successful. There are several instances where their SRI plot has failed, often due to a poor understanding of the principles, or mistakes in the practice, as also in some cases like at Auroville in Pondicherry, where the alkalinity of the soil seems to have weighed against it.

Small farmers have in many cases not been as successful as their bigger counterparts, who seemed to be in a better position to take risk. At another level the propagation of SRI in India, at least by governmental agencies, has not accounted sufficiently for a poverty focus. Small and marginal farmers in dryland areas seem to need greater support in making the transition than is understood. While civil society organisations have been quite sensitive to these aspects in some cases, their enthusiasm to see the results of SRI has often not been matched with technical competence to get successful results, and there is a strong case to be made for capacity-building of practitioners here. There is also a need for greater state-civil society interaction at an institutional level, something that the WWF Dialogue project has achieved in good measure.

The SRI study presented here has in some ways also looked at regions' experiences and compared and contrasted them for greater learning and it is evident that there are several cross-learning opportunities. For instance, while Andhra Pradesh has a lot to offer to SRI in Eastern India given its relatively stronger technical competence, eastern India has a pro-poor focus that Andhra Pradesh could learn from. Spread of SRI through policy also needs to consider different kinds of vehicles for promotion, for instance, targeting only departments of agriculture for future SRI work might miss out on the opportunity that proactive irrigation departments have shown in many of the states. SRI is rich with possibilities in India but also relatively new. SRI is also a case where learning from other countries, especially the South is very useful. South-south cooperation here is not a cliché, India has more to learn from Vietnam and, as was evident in Satyanarayana's case, from Sri Lanka, Bangladesh, Nepal, Myanmar and even Pakistan where interesting partnerships are emerging. For all these to happen, innovation needs to be seen in more systemic terms and not in strict economic terms of yield and productivity increases.

SRI Timeline

Year	SRI Details Or Event
1963-64	R H Richharia of the Central Rice Research Institute, Cuttack proposes a scheme for clonal propagation of rice that involves separation of 10 – 12-day-old seedlings and multiplying pure seeds. This does not involve any other agronomic changes and indicates an 'SRI' type of research though like almost all other researchers (and most farmers) was neglecting/ ignoring roots. (SRI has been referred to as the 'root revolution' recently.)
1980s	The 'one grain rice revolution' of Richharia tried out by several farmers in India keen on sustainable agriculture, seen by them as a way to multiply seed production of indigenous and exotic varieties. SRI unknown to most though potentially a 'better' way to achieve the same end using similar principles of younger seedlings.
1999	LEISA magazine (then ILEIA) carries article on SR by Justin Rabenandrasana, secretary of Association Tefy Saina. This was the first published piece on SRI after Fr. de Laulanie's 1993 article in TROPICULTURA (Brussels). Organic farmers like Reddy and Ramaswamy read and experiment using native cultivars. In Auroville, Pondicherry, a pamphlet in French in brought by a visitor from Madagascar, which is translated and an experimental SRI on a small plot of 6 cents carried out.
2000	Annapoorna farm (Auroville, Pondicherry) conducts systematic experiments with SRI on small plots with native varieties. SRI gives lower yields. Pushpalatha of Ekoventure hears about SRI from Herbert (Auroville) and Nammalvar, a well-known organic agriculture activist. Ramaswamy Selvam, from Erode and the current President of All-India Association of Organic Farmers, chooses to experiment with SRI.
Sep-00	Uphoff presents SRI in a seminar at the Ministry of Agriculture (Krishi Bhawan, New Delhi), no discernible response. Arranged by Rita Sharma, additional secretary in the Ministry at the time, a Cornell alumna and former student of Uphoff.
2000	Dr. T. M. Thiyagarajan, Professor of Soil Science in Tamil Nadu Agricultural Universtiy (TNAU), learns of SRI through a collaborative research program on water-saving rice production organised by Wageningen Agricultural University (Netherlands), for which Uphoff was an advisor, seeks to try it out, focusing on alternate wetting and drying of the paddies, and use of soil-aerating cono-weeder.

Late 2000	Dr. Ajay Kallam the then director and commissioner of Agriculture of Andhra Pradesh convenes a meeting in Krishna district attended by various agriculture officials and discusses sustainable agriculture and the new SRI method and its benefits.
Jan-01	Kallam publishes an article on SRI in 'Padipantalu', the monthly journal of the Department of Agriculture, Andhra Pradesh. Perhaps the first Indian article on SRI.
2001	Narayana Reddy, a leading organic farmer from Karnataka, gets to read an article on SRI by CIIFAD in a magazine at a conference in France. Later visits the SRI experiment at the T. S. Srinivasan Centre for Rural Development Training in Bethlapally, Hosur, Tamil Nadu. His wife suggests direct seeding instead of troublesome transplanting. He is excited by the results and enthuses fellow farmers and NGOs in his extensive, informal network of the organic farming community.
	Annapoorna farm continues systematic experimenting with SRI on small plots and native varieties – yields are lower with SRI. Pushpalatha gets a farmer, Ramaswamy of Pillayarkuppam , to try SRI on 10 cents. Also starts SRI with a women's group in TN Palayem village on a few cents of land.
2001	Forty more farmers try SRI, after interaction with Ramaswamy Selvam. Mixed results, due to drought. 20,000 pamphlets on SRI distributed in an organic conference in Tamil Nadu.
2001-02	First SRI experiments by research establishment in India by T. M. Thiyagarajan, TNAU, who collaborates with Dr. H. F. M. Ten Berge of WAU's Plant Research International (PRI) in the Netherlands. At the end of these observation trials done with alternate flooding and draining, Thiyagarajan reported that though there were no spectacular yield differences, the study confirmed that flooding was not needed to maintain yields (50-56% water saving was observed). Trials still maintain heavy chemical fertilizer use, as is the norm in India.
2001-02	Dr. Thiyagarajan, TNAU, initiates 3 more observation trials on SRI, having attended a WAU-PRI workshop held in Nanjing, China, in April 2001, where TMT and Uphoff first got acquainted and discussed SRI in more detail.
Apr-02	A. K. Singh of IARI Water Technology Centre in New Delhi puts up 2 demo plots with wider spacing after hearing Uphoff at IRRI. Gets one of his staff to undertake PhD thesis research on some agronomic aspects of SRI. Thiyagarajan, the only Indian who attended the first international conference on assessment on SRI at China in April, where he learned much more about SRI.

2002	Severe drought leads to discontinuation of SRI outside the governmental system in Tamil Nadu. However, based on the encouraging results obtained during the Observation Trials, a policy proposal was sent by the TNAU to the Ministry of Agriculture in 2002. The Tamil Nadu government sanctioned $50,000 to carry out 100 Adaptive Research Trials (ARTs) with hundred farmers in Cauvery delta basin (Thanjavur, Nagapattinam and Tiruvarur districts) and in Tambiraparani river basin area (Tutucorin and Tirunelvelli districts).
2002 *Kharif*	Narayan Reddy does SRI on half acre, and his close farmer associates in Karnataka do the same on smaller plots. Results anxiously awaited by many NGOs and other farmer friends.
2002	Annapoorna farms try out direct seeding with SRI. The alkalinity of the soil is suggested as a possible reason for lack of SRI effect during Uphoff's visit to Annapoorna farm in December 2002. Ekoventure encourages farmers in 3 villages to do SRI.
May-02	Uphoff gives a series of talks in India to senior officials of Tamil Nadu and Andhra Pradesh, at the M. S. Swamnathan Research Foundation (MSSRF), at NCAP (National Centre for Agricultural Research and Policy Analysis) at ICAR, Pusa and statewide meeting of the Agronomy Society at ANGRAU. MSSRF takes up SRI in its biovillage at Pillayarkuppam (on 2 cents in its 2-acre campus). Uphoff offers through CIIFAD to support visit of senior officials of AP and TN to Sri Lanka to see SRI being practised, if these state governments can/will pay the transportation of their officials to Colombo.
5 Jun-02	Narayan Reddy shares his experiences about SRI during a programme of the Timbaktu collective (TC), an NGO in Anantapur district of AP, to celebrate World Environment Day with a sustainable agriculture focus. TC takes up SRI.
Jul-02	TC arranges for SRI exposure visit of seven farmers, including women involved in transplanting, to Narayana Reddy's farm.
Sep-02	Timbaktu Collective initiates experiments with wider spacing and later tries out SRI in a farmer's field.
Oct-02	Thiyagarajan (TNAU) and Aldas Janaiah (Indira Gandhi Development Research Institute, formerly post-doc at IRRI in the Philippines) visit Sri Lanka, hosted by SRI colleagues there and supported by CIIFAD for travel and local costs; larger delegation from AP and TN governments did not materialise as planned because of last-minute failure of govts. to give travel clearances.

Nov-02	Uphoff makes presentations on SRI at 2nd International Agronomy Congress in New Delhi and at Ministry of Agriculture, which still elicits little response.
	In Tamil Nadu adaptations of SRI emerge. Gopal Swaminathan uses double transplanting of rice seedlings after concluding that intense sunlight in the Cauvery Delta would be difficult for young seedlings to withstand (Kadiramangalam method).
	PRADAN undertakes its first experimental trials in West Bengal.
Dec-02	Narayana Reddy visits Timbaktu again and discusses with farmers about sustainable agriculture and SRI methods, followed by visit of more farmers from the mandal to Narayana Reddy's farm where they participate in the harvesting of SRI crop.
Dec-02	Uphoff participates in international workshop at MSSRF and speaks on SRI; tries to interest Secretary of Agriculture for Kerala State, offers to arrange visit to Sri Lanka; no follow-up; also encourages Swami Agnivesh to try out SRI at his ashram in Haryana state; no evident follow-up; visits Pondicherry and the farms at MSSRF and Auroville, alakalinity of soil seems to be a factor in poor SRI results in the latter; MSSRF staff are pleased with their results.
	2003
Early 2003	K.Jaggaraju of Dirusumarru in West Godavari district, exhibits a heavily tillered rice plant (140 tillers) at the Kisan mela (farmers festival) attended by Dr. A. Satyanarayana of ANGRAU who is initially skeptical about the results from a single seedling.
Jan-03	Timbaktu Collective takes up SRI on 7 varieties. Contact made with Uphoff and material downloaded and requested for.
Jan-03	Dr. A.Satyanarayana and Dr. Jalapati Rao from ANGRAU visit Sri Lanka on an exposure visit supported by CIIFAD to get first-hand information about SRI. Satyanarayana returns fully persuaded of SRI merits and of need to promote SRI in all the districts and eco regions of Andhra Pradesh.

2003 *Kharif*	SRI extends to Karnataka through farmers' networks. Mrtyunjayappa arranges a pre-season workshop for 70 farmers where Narayan Reddy speaks on SRI. Appaswamy, another SRI practitioner, is invited by a farmers' group in Dakshin Kannada district. A Bangalore-based NGO, Green Foundation, organises a tour for farmers to Narayan Reddy's SRI field, later invites Appaswamy to demonstrate SRI in two villages (250 farmers attend). Dr. R. Dwarakinath, former Director of Agriculture for Karnataka and then VC of University of Agricultural Sciences, Bangalore, long retired from government service and now active in NGO work for agricultural development (Cornell alumnus and former student of Uphoff), begins taking interest in SRI, visits Narayan Reddy's field, and gets DOA and UAS interested in SRI evaluation.
	CBTMPBS, a centre at the University of Agricultural Sciences in Bangalore, organises six trials in farmers' fields. Their mandate, dictated by a tank rehabilitation programme funded by the State Govt. and World Bank (in Kolar, Tumkur and Chitradurga districts).
	250 on-farm trials in 22 districts of AP undertaken by Alapati Satyanarayana of ANGRAU. 'Annadata', a farmers' magazine, carries a lead article on SRI. Most farmers in AP hear about SRI through 'Annadata' henceforth. Farmers in Godavari districts take a lead on SRI experimentation. A roller-marker to reduce labour time for the SRI transplanting operation invented in the first season. Average yields in Kharif in AP trials: 8.34 t/ha, and a high of 16.2 t/ha. The AP SRI results contribute significantly to changing perceptions on SRI both nationally and internationally.
	SRI taken up in both seasons (Kuruvai and Thaladi) for the first time in Tamil Nadu. TNAU undertakes 100 adaptive trials in Tamiraparani river basin. In Pondicherry Pushpalata collaborates with the Tank Rehabilitation Programme and gets first large-scale SRI experiment done by seed producer Abdullai of Kaaterikuppam village on 4 acres. High yield of 10 tonnes/ha obtained. MSSRF's trial plot in biovillage leads to farmers trying SRI on their own.
	PRADAN, a national NGO, begins larger-scale experiments on SRI in Eastern India.

Sept-2003	International Symposium on 'Transitions in Agriculture for Enhancing Water Productivity' held at the Agricultural College and Research Institute of TNAU, Killikulam, in collaboration with ICAR and IRRI. SRI was referred to as 'Transformed Rice Cultivation' in this meeting. Uphoff invited to make presentation on SRI and meets organic farmers Narayana Reddy and Selvam Ramaswamy with whom he had email exchanges. Uphoff visit in AP hosted by A. Satyanarayiana, visiting 12 villages and research stations in Godavari and Warangal areas. Visit to home of N. Subba Rao in Achanta village most interesting; Rao known as 'Mr. Green Revolution' for being first farmer to use IR-8, previously visited by many international rice scientists; now using SRI with great satisfaction; Uphoff and Rao describe SRI a 'the root revolution'.
30 Sep-03	Uphoff seminar at the Water Technology Centre of IARI, Pusa, evokes interest.
2003 *Rabi*	Many farmers cultivate SRI in AP on over 10 acres. One farmer (Mr. N.V.R.K.Raju) planted SRI on over 40 ha. average 9.7 t/ha productivity was achieved with one farmer Lakshman Reddy achieved record yield of 17.2 t/ha from 9 acres [one plot 20 t/ha].
	372 acres of paddy are grown in the Mustikovila tank-irrigated area using SRI principles by farmers of four villages under guidance of Timbaktu Collective and Narayana Reddy. Farmers save their standing crop by applying one of the SRI principles (non-flooding). A four-month crop was made possible with two-and-a-half months of water. This single largest 'SRI' experiment in India by civil society even before SRI gains popularity.
2003 *Rabi*	SRI spreads in Karnataka with more NGOs taking it up. More trials also by the CBTMPCS.
2003-04	In Tamil Nadu, TRRI of Aduturai conducts Adaptive Trials with 94 farmers from 50 villages (17 farmers yields of 5 t/ha; highest 7.925 t/ha). NGOs interested in sustainable agriculture spread SRI to farmers but refer to SRI differently.
	2004
Jan-04	American delegation (American Santa Fe watershed association) visit East Godavari district to study the SRI system as part of study exchange program. SRI crops in AP withstand cyclone while neighbouring fields suffer from lodging. Vernacular press covers Uphoff's visit to SRI fields extensively.

Mar-04	NATURE article on SRI titled 'Feast of Famine', an issue that starts the 'Rice Wars' debates. Alapati Satyanarayana responds to the views expressed in the article by critical scientists who had no direct experience with SRI. Indian results figure prominently in the international debates.
Apr-04	An 8-member Bangladesh delegation from the IRRI-PETRRA project visits AP to examine the special features of SRI trials in AP that led to high success of the system.
	Govt. of India allots funds for organising 800 demonstrations on SRI to the State Department of Agriculture [Andhra Pradesh], ICAR funds another 250 'frontline demonstrations' on SRI to ANGRAU. Govt. of India asks ANGRAU to train State Nodal Officers from different States on SRI.
2004 *Kharif*	A GO passed by Dept of Agriculture providing guidelines on growing SRI. SRI in Kharif estimated over 10,000 acres in AP. In Pondicherry a field school organised on SRI by Ekoventure for 40 women through the Tank Rehabilitation Programme. Most state governments offer incentives for SRI through input subsidies on weeders.
2004	M.S. Swaminathan Research Foundation 14th Annual Report 2003-2004 reports on SRI results showing yields of 7.5 and 9.95 t/ha compared to 4.056 t/ha with conventional methods and virtually no difference in labour inputs (p. 80).
	In Karnataka the number of farmers increases through NGOs. Government is actively involved in scaling up activities, CBMTCPS distributes seeds to 200 SRI farmers; state agricultural department sets itself a target of 25 farmers per district. More publications on SRI emerge from the Green Foundation and CBTMCPS, apart from several articles in regional print and electronic media.
2004 *Kharif*	Anand Agricultural University, Gujarat and the rice research station there undertake a comparison of SRI with ICM and conventional rice growing
	IWMI India Program funded by Tata Trust conducts study on rice in Jhalda and Balrampur blocks of Purulia district of West Bengal, involving 110 farmers, the first large-scale independent evaluation of SRI.
Aug-04	Scaling-up of SRI outside the research system begins in Tamil Nadu for the first time through the Department of Agriculture. SRI is promoted under the 'Integrated Cereal Development Programme-Rice' with a target of 9000 acres.

Sep-04	Timbaktu Collective and Laya, civil society organisations in AP, visit Sri Lanka to gain an experiential understanding of SRI practices, return excited about the knowledge of actual SRI organic practices and Premaratna's ways of disseminating SRI.
29 Sept-04	Article in The Times of India reports on spread of SRI in Karnataka state, with strong endorsement from the Minister of Agriculture
Oct-05	A. Satyanarayana and colleagues make presentation on SRI to the Directorate of Rice Research.
2004 *Rabi*	WWF team visits ANGRAU to explore water-saving with SRI, being interested in how this could benefit aquatic ecosystems that are under pressure from agricultural demand for water. This potential explained in their dialogue bulletin as one of the options in the mid-Godavari basin to achieve environmental benefits from reducing groundwater exploitation and canal water utilisation. Consequently, an interesting partnership between WWF dialogue team and ANGRAU is undertaken with 250 farmers field in 10 districts of AP. This is the first large-scale partnership on SRI in India.
	Dr. Madhu Nair, an ICAR scientist initiates trials in Palakkad district of Kerala on SRI out of personal interest. Activity spreads following year.
4–7 Nov-04	Alapati Satyanarayana and T M Thiagarajan present papers on SRI along with Uphoff at the World Rice Research Conference at Tokyo where a small workshop is held on SRI.
Nov-04	IWMI TATA issues a notification for call for papers on SRI as part of its Annual Partners Meet on water-related issues. Separate session on SRI planned. This is the first attention paid to SRI in a national-level conference.
Dec-04	In Kerala a Krishi Vigyan Kendra (Farmers' Science Centre) at Mitraniketan takes on the evaluation and promotion of SRI with technical and financial support from CIIFAD and guidance from T.M.Thiyagarajan. Average yield of 7 t/ha compared with the state average of 3 to 3.5 t/ha reported. KVK has trained about 1000 farmers and more than 500 extension workers from government, local bodies, NGOs, voluntary action groups, private agencies, etc. on SRI. State-wide workshop on SRI held 24 November, 2004. SRI also discussed in the 'Save our Rice Campaign' organised by an NGO Thanal in Kerala involving national and international activists and policy makers in Dec 2004.

	Rajeev Natarajan writes about SRI in India together magazine about Perumal, a farmer experimenting with SRI in Alandur in TN.
	2005
Jan-05	Selvam Ramaswamy writes about farmers experiences with SRI in Lower Bhavani Project area of Erode in *Jalavani*, a farmers' newsletter brought out by Jalaspandana.
7 Feb-05	WALAMTARI, a training wing of the irrigation department of Andhra Pradesh government conducts its first training programme for SRI to induct 'master farmers' who would spread SRI in their regions. Another workshop repeated in March and a video produced to promote SRI.
Feb-05	IWMI TATA Partners Meet held in Anand, has a session on SRI and a keynote address by Norman Uphoff, which evinces a lot of interest from the gathering.
Mar-05	November 2004 issue of Asian Biotechnology and Development Review on 'Rice research in Asia' has no mention on SRI. Suleka Sule writes an article on SRI in India Together based on perceptions at the IWMI TATA meet but characterises SRI as a 'magic potion', which is contrary to the views of the conference speakers and participants on SRI.
	IRRI Annual Report speaks of SRI perhaps for the first time, but indicates that its trials on SRI providing lower yields for farmers than direct transplanting or ICM. (IRRI's first SRI trial gave a yield of only 1.2 t/ha, and its second trial, only 3 t/ha; SRI results have often been lower on experiment stations than on farmers' fields, focusing attention on the status of soil biota in on-station soils that have received chemical fertilisers and biocides for many years).
28 Apr-05	The Hindu features an article on SRI but attributes the introduction of SRI into South India to IRRI scientists! Case of misreporting of SRI in media; also another instance where a journalist features SRI as a miracle.
10 May-05	SRI Paddy Farmers Field day organised in Mahboobnagar District as part of WWF Project.
13 May-05	The Hindu features an article on SRI in Pondicherry about the work of 20 women farmers growing SRI and awards distributed by the organisation Palmyra.
16 May-05	WWF- dialogue project holds a meeting on merits and demerits of SRI system which has both SRI and non-SRI farmers apart from researchers, extension workers and the media.

31 May-05	Govt. of India (Ministry of Agriculture) issues press release advising farmers to adopt SRI 'wherever feasible,' recommended for Boro Rice.
June-05	CRRI Cuttack undertakes a study on SRI for the kharif season for rainfed ecosystems as compared to ICM and normal practices. L.C. Jain a reputed economist and former member planning commission writes article in Deccan Chronicle on SRI.
	Infochange India carries article on input-saving possibilities of SRI that emphasises its potential given the declining paddy cultivation in several states of India due to decrease in canal water availability.
13 Jun-05	L.C. Jain, eminent former member of Planning Commission and development economist writes in Deccan Herald on SRI 'More Water? Lower Rice Yields'.
2005 *kharif*	AP Dept of Irrigation implements plan to introduce SRI on 100,000 hectares in its major irrigation schemes through training involving 1000 SRI master farmers backed by 25 NGOs. This constitutes biggest trial of SRI undertaken anywhere in the world.
	WWF decides to continue the SRI results in kharif as well with a greater participation by civil society organisations and with continued technical support of ANGRAU. Coverage includes 250 farmers, 11 districts, 6 rice research stations.
Jul-05	WASSAN, an NGO takes the lead on weeder design based on its inputs from farmers. As part of the WWF dialogue project facilitates a workshop on technical innovations in SRI and improvements on markers and weeders. Workshop results in several new designs for evaluation by farmers. ANGRAU technical staff also participate in the workshop. Mandava weeder later popularised by WASSAN among farmers and new markers introduced.
Sep-05	Articles on SRI by WWF Dialogue staff Vinod Goud is featured in Down To Earth and Indian Express as 'Rice Does not Need water'. Jalaspandana article on SRI and participatory irrigation management, reports 36 FFS on SRI and acreage of 160 acres.
15 Nov-05	AP Chief Minister announces Rs 4 cr for popularising SRI following a visit Nagaratnam Naidu's field one of the project sites of the WWF - ANGRAU project. Widely reported in the media.

Nov-05	WASSAN (Watershed Support Services and Activities Network) a Secunderabad based NGO launches a website on SRI with manuals in Telugu and resource persons in Andhra as part of the WWF project.
Rabi 2005	Department of Agriculture in its Rabi Campaign mentions promotion of SRI 'In areas where water recedes early, use Madagaskar (sic) system or system of rice, intensification for water saving in rabi'. Areas where it could be tried are Bihar, West Bengal, Assam, Eastern UP, Orissa
25 Nov-05	News item in The Business Line on the efforts of the Tripura govt. on SRI.
29 Nov-05	WASSAN organises field day in Utthunur village of Gandhari Mandal in Nizamabad district. 250 farmers participate to share experiences and queries on SRI.
	2006
Mar-06	International Dialogue on Rice and Water at IRRI on 7–8th. WWF project team in India participates with farmers from AP (K V Rao and Kishan Rao) and takes the debate to the hitherto leading opponent of SRI.
Apr-06	PRADAN results for 2005 with 163 families in rainfed Purulia of West Bengal indicate yield increases of over 5 tonnes per hectare over normal.
29 Jun -06	ANGRAU in Andhra Pradesh hosts multi-stakeholder review of different experiences with SRI in this state. The registrar of the university estimates SRI acreage in AP to be 100,000 acres.
Jul-06	Himanshu Thakkar in article in Financial Times critiques the 11th plan approach paper of Planning Commission of India for ignoring the potential of SRI for Indian agricultural growth.
5 Aug 06	The Hindu in an article quotes Professor Shergill from Institute for Development and Communication who urges the state research establishment to focus attention on improving the competitive advantage of Punjab farmers in wheat and rice by drawing indigenous lessons from SRI.
Aug 1-8	Directorate of Rice Research undertakes training programme on SRI for officials from State Department of Agriculture.
Oct-06	Norman Uphoff visits India (AP and Karnataka) and Financial Express and The Hindu carry SRI articles based on interviews with him.

Oct-06	International Rice Congress held at Delhi with various stakeholders participating. No discussion on SRI in any of the plenaries indicating continued apathy of the international rice research establishment to SRI as a prospect. High on the agenda is GM rice. Poster sessions by WWF team. Uphoff participates in one of the sessions and flags concerns on SRI.
15 Oct-06	Workshop by AME Bangalore on 'Innovations in SRI Method of Paddy Cultivation'.
Nov-06	The first ever comprehensive national seminar on SRI being organised by Directorate of Rice Research (DORR) Hyderabad with support from the WWF Project. Farmers, researchers, government officials across the country expected to deliberate on future prospects of SRI in India.

APPENDIX 2

SRI and the Rice Establishment: A Chronology of Resistance

One of the reasons for the low awareness of SRI and its uptake is the resistance of the formal rice research establishment to SRI. This is slowly changing with increased spread in many countries and scientific results from research laboratories evaluating SRI. We provide a few excerpts from the history of SRI's contests with rice research.

1991	Laulanié gives a seminar on SRI at the University of Antananarivo expecting interest and cooperation, but was met with derision from researchers.
1992	At a national workshop in Madagascar organised by Tefy Saina the Minister of Agriculture endorses, but government agricultural technicians refuse to take SRI seriously. Their evaluations could not replicate the results of Tefy Saina so the innovation was dismissed.
1993	Uphoff of CIIFAD visits Madagascar to help implement a USAID-funded project to preserve the rainforest ecosystems in Ranomafana National Park. Tefy Saina willing to assist CIIFAD saying that SRI methods could raise yields to 5, 10, even 15 t/ha, without requiring farmers to get new seeds or to use chemical fertiliser. Uphoff meets the representative in Madagascar of the IRRI to get a scientific opinion. IRRI had heard of SRI, but had not evaluated it. Government rice scientists evaluations however got yields over 5 t/ha with SRI methods, well above the national average, but these were not of interest to IRRI since such yields could be obtained with its own improved varieties and recommended inputs. Uphoff in retrospect feels that even twice the yield without requiring use of any purchased inputs, should have interested IRRI researchers.
1994 - 99	SRI Farmers with Tefy Saina average 8 t/ha (some 12-14). Results continue over five years, number of SRI farmers up from 28 to 400; could have been over 1,000 if USAID had not withdrawn support.
1999	IRRI/ Madagascar programme finally does some scientific evaluations of SRI in 1999, with CIIFAD funding. SRI effect not observed because full set of practices not tested. Similar trials of SRI were conducted later by scientists of the West African Rice Development Association (WARDA) in the Ivory Coast and the National Agricultural Council in Nepal. Like at Madagascar, without water control. Researchers assume disconfirmation of SRI efficacy.
2002	Tefy Saina and CIIFAD with the China National Hybrid Rice Research and Development Centre (CNHRRDC) organise an international conference on SRI partly to counter continued criticism from IRRI scientists as exceeding the genetic barrier.
2004	'International Year of Rice' witnesses 'Rice Wars' of SRI. Continued neglect and misrepresentation.

The debates between SRI proponents and the rice research establishment are actually about two different paradigms of doing research and a certain incompatibility of methods of verification arising out of these. This continues to date. A recent email discussion in the SRI Rice group of Cornell University had heated discussions between Andy McDonald and Peter Hobbs from Cornell University on the one hand and Norman Uphoff and other SRI practitioners from across the globe. There were 35 conversations in less than a week, debating the protocol used by McDonald and Hobbs in their meta-evaluation of SRI.

Some of the issues that emerged are:

1. Methodological difficulties posed to rice science by SRI: Methodologically scientists as a rule prefer to evaluate the ceteris paribus effects of just one or two changes at a time, rather than addressing the more complicated hypothesis of synergy that SRI puts forward. Testing SRI, with six factors, is too complex.
   The other difficulty that rice scientists have had is based on the maximum yield possible in rice. Analyses of rice plant potential, based on empirical information, suggest that 15 t/ha represents a kind of 'yield ceiling' or 'biological maximum' for rice. Indeed, the highest yield attained at the IRRI headquarters field station in Los Baños was obtained more than 30 years ago, 11.5 t/ha with IR-8, so 12 t/ha has been seen as practically a maximum attainable yield, surpassed only with the hybrid rice varieties developed in China. These data, SRI practitioners point out, are from rice plants grown under continuously flooded conditions and have lost a large part of their roots. Hypoxic soil conditions can cause rice plants to lose up to three-fourth of their root systems by the time of flowering, when the grain reproduction phase begins. SRI operates on different principles and rice science has not been able to rework and revise its understanding based on field-level observations and explain this 'anomalous' phenomenon of SRI.
2. Faulty measurements A common objection to SRI to reports of 'super-yields' has been to deny them, suggesting that they must have been measured incorrectly, that there had to be faulty sampling or incorrect calculations.
3. SRI as backward: Some of the objections of SRI have also been based on the perception by scientists that SRI was 'backward' and not 'modern'. The use of rotary weeders, one scientist remarked, estimated to cover 170 km on farmers' fields was dismissed as unpractical even though farmers were using it. It was later realised that he believed in the spread of herbicides and had collaborations with companies to promote them.
4. Incomplete knowledge of science of soil biology: The response of some scientists have been 'I do not believe in SRI', little realising that the question was not a discussion of belief but a matter of science and engaging with the research questions that SRI poses. Yet another response has been that SRI is not something that we already know, it cannot be done on a large scale. In his communication with IRRI scientists Uphoff realised that IRRI had no data on single seedlings (no numbers) and had not heard about phyllocrons.[28] Neither had they done any work on root resistance and its synergistic possibilities.

[28] Interview with Uphoff dated 24th February 2005.

Some of the approaches of IRRI research, notably NPT (new plant type), were counter to the emerging scientific understanding in SRI. NPT sought to cut down the number of tillers whereas newer scientific evidence emerged from factorial trials in October 1997 by CIIFAD has established a positive correlation between number of tillers and panicles, which rice scientists often assumed to be negative or non-existent.

5. On-farm results higher than on-station: Yet another difficulty that rice scientists have had in evaluating SRI is the rather unusual fact of on-station results being less than on-farm trials. This is quite counter to the usual thinking on 'bridging the yield gap' between on-station trials and farmers' fields. At IRRI, average SRI trial yields have been only 2.1 t/ha, because the biota in on-station soils are likely to be less abundant and diverse because of years of monocropping and fertiliser and agrochemical applications. Understanding this phenomenon requires a different kind of expertise, however IRRI no longer has any soil biologist or ecologist working at Los Baños so there is little knowledge of what is going on in its soils.[29]

Understanding Scientific Controversies: The Politics of Knowledge in SRI

At a more fundamental level, the debates on SRI also relate to debates on knowledge and the politics surrounding it. This was very evident in 2004 the year of the International Year of Rice (IYR). IYR 2004, was the first time since 1960 when the United Nations General Assembly started the International Years when the attention of the international community has focused on a single crop. The IYR 2004 rates as one of the more concerted efforts by scientists to place scientific agendas in public discourse. Of the six main objectives apart from the improvement in nutrition sought to be promoted through golden rice, the mechanisms through which these challenges were sought to be addressed indicate that alternative systems and conceptions such as the System of Rice Intensification (SRI) found little mention in the programmes of IYR 2004.

To appreciate why this is so, it would be interesting to follow some of the debates around SRI in 2004. The first, early in the year was following the Nature article that was captioned 'Proponents call it a miracle. Detractors call it smoke and mirrors. Will SRI feed the hungry or needlessly divert farmers from tried and true techniques?' (Surridge 2004). The 'debate' was between IRRI scientists who dismissed SRI as anecdotal, lacking peer review, and technically flawed. In response, an SRI scientist from India, Dr. Alapati Satyanarayana, ANGRAU, argued that farmers' experience based on trials across regions indicated much satisfaction due to increased yields and water saving. The phenomenon could be scientifically explained, he maintained, and critics were ignoring the role of synergy in producing the reported remarkable effects.

[29] More information on the scientific controversy can be got from Uphoff 2001, 2002 and 2005. Also see Shambu Prasad et. al. 2005 on 'Understanding Scientific Controversies' for some of the challenges that SRI presents.

He expressed the hope that the scientific community would collaborate in verifying the facts (Satyanarayana 2004).

The second debate was played out in the IRRI journal Rice Today between Norman Uphoff, director of the Cornell International Institute for Food, Agriculture and Development (CIIFAD), and Thomas Sinclair, an agronomist with the U.S. Department of Agriculture. Uphoff argued that SRI is best situated to answer the needs of farmers in the twenty-first century and that farmers have amply demonstrated this across the world. Sinclair, however, dismissed SRI as not meriting serious attention and referred to it derisively as a 'UFO' – unconfirmed field observations.[30] Variants of the debate have also been played out on issues surrounding transgenic rice.[31]

Controversies are an integral part of the collective production of knowledge; disagreements of concepts, methods, interpretations and applications are the lifeblood of science and one of the most productive factors in scientific development. The recent literature on scientific controversies has pointed out that political, social or historical subtexts need to be recognized in controversies and the scientific community often has roles in furthering them (Mendelsohn 1987, Engelhardt and Caplan 1987).

This clearly seems to be the case in SRI. The general methodological/ontological disputes are also a part of the subtext of the controversy. These include how to conduct field trials, how to collect observations, how to analyse the data, and equally important, how SRI undermines a deeply cherished and well established tradition of rice cultivation through flooding. At another level, the controversy concerns two 'ways' of doing rice cultivation – the one that is established and 'scientifically' supported by the international rice research science community and the other, thus far subaltern groups of farmers, social scientists, and very few agricultural scientists. The former argues for water-intensive, fertiliser-intensive, pesticide-intensive, and energy-intensive methods, accessible only to rich and medium farmers, searching for solutions to the problem of increasing the yield of rice within that paradigm. The latter attempts to develop an alternative method, which is not water; fertiliser; pesticide; or energy-intensive and is affordable to all farmers, especially the poor and marginal farmers. In fact, organisations such as the Institute for Science in Society (ISIS) have been critical of the role of international agricultural research centres for their inability to stay free from corporate agendas and use SRI as an example.[32] The recent International Rice Congress at Delhi in 2006 seems to further such claims.

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[30] For details on the debate refer http://www.irri.org/publications/today/pdfs/3-3/grain3-3.pdf

[31] See Suman Sahai. 'Should India Cultivate GM Rice?' The Hindu (India), 5 April, 2004 for an argument for SRI as promising compared to GM rice and the response by Kameswara Rao in Agbioworld newsletter where he uses Surridge's article to term SRI as 'a false-positive technology'. http://www.agbioworld.org/newsletter_wm/index.php?caseid=archive&newsid=2100

Accessed on 20 Feb 2005.

[32] http://www.i-sis.org.uk/LIMFNR.php

What is also not recognised in the 'rice wars' controversy is that agricultural science seems to have undergone a change in some important way. What we have today quite often is not a pure science or an applied science or technology, but a techno-science. The new terminology signals the fact that it is not always science that precedes technology or that science and technology develop in a parallel way, at times borrowing from each other, but that they interact very strongly to develop new knowledge claims and new reconfigured material entities. The techno-scientific controversy therefore is a more complex controversy where the success of a techno-scientific activity can be challenged not only by appealing to observation but by posing questions about the replication of the sanitised laboratory methods to a messy world, or vice versa. In the case of SRI, the question that is being asked is: if this really works in the field, why is not replicable in the laboratory? SRI has evolved quite independently of the understanding of controlled laboratory experiments leading to a technology that could be replicated through a process of on-station and on-farm trials, leading to adoption by farmers. Behind such an understanding lies the inherent assumption that innovations such as SRI can be treated as a 'technology', like any other improved variety.

APPENDIX 3

Research and Non Research Actors in the SRI Innovation System

Research Actors

Actors	Brief Description
TNAU, ACRI, TRRI	These research organisations in Tamil Nadu have been leading the official SRI and T M Thiagarajan has been one of the champions in TN
ANGRAU - Dept. of Extension	Alapati Satyanarayana and his staff have been instrumental in carrying out trials in all the 23 districts of Andhra Pradesh and the results have placed SRI in the world
Rice Research Stations	There are several such stations in the country though only a few have shown interest like the Marateru and TRRI that too due to a few individuals like P V Satyanarayana in Marateru or Chelliah in TNRRI or Jalapti Rao of Warangal Agricultural Research Station
CIIFAD	Norman Uphoff has provided very useful research information to all researchers and farmers directly or through website that CIIFAD hosts
IARI, Water Technology Centre	Some trials were done in 2002 on SRI here but there does not seem to be continuity
PRI, Wageningen	This institute supported the Tamil Nadu trials
ICRISAT	Scientists from soilmicrobiology and pathology divisions have shown interest and have been involved in studies as part of the WWF ANGRAU project
IWMI, Patancheru	There has been some recent interest in evaluating SRI from IWMI
IWMI TATA, Anand	SRI was one of the themes of the IWMI TATA partner meet and they were involved in a study evaluating SRI in Purulia district
AAU, Gujarat	The rice research station in Gujarat started evaluation trials on SRI
UAS, Bangalore	Has taken up SRI activities as part of the tank rehabilitation project. Dwarakanath, an ex chancellor of the institute has been a driving force

CRRI	Has just started evaluations on SRI as part of a recent ICAR project
DORR	After initial hesitation has taken to SRI with enthusiasm taking on research on several aspects of SRI. Working in collaboration with ICRISAT scientists and others as part of the WWF project
KVK Undi	Extensive experimentation at the Undi station on spacing, varieties etc.

Note:
The list is again not exhaustive. Recent actors have been underreported

Non Research Actors in the SRI Innovation System

S. No	Name	Description
		SRI enthusiasts / activists/ trainers
1	Nammalwar	A leading organic farmer proponent in TN, travels extensively, has followed SRI since 2000 and is a proponent Tamil Ena Vazviyal Eyakam.
2	Ajay Kallam	Was instrumental in getting the first article in Padipantulu, the AP govt's agricultural magazine as early as 2001 when in agriculture dept.
3	Kadiramangalam Gopal	The pioneer of Kadiramangalam SRI which involves double transplanting; has around 60 acres of paddy land under SRI this season, at different stages of crop growth. Recently reported growing the cotton crop using SRI principles.
4	Narayana Reddy	Leading organic farmer who considers SRI innovation of his lifetime, advises farmers in several states on SRI, innovated and introduced direct seeding and has instances of using sprinkler system for rice.
5	Premaratna	The Sri Lankan farmer who has trained over 4000 farmers on SRI and trained Alapati Satyanarayana.
6	Revathy	An organic farming proponent in Tamil Nadu who travels and organises road shows to encourage farmers to take SRI.
7	Jagga Raju	Farmer from West Godavari who intutively proved that rice is not an aquatic plant. A seed farmer who grew rice in flower pots.
8	Kishen Rao	Organic farmer working with WASSAN documents and training farmers.

9	Selvam Ramaswamy	Probably the first farmer to take to SRI in 1999 in India even before formal trials began.
10	Dr. D. L. N. Prasad	Plastic surgeon Hyd. Kollur village enthusiastic about SRI described in Uphoffs' field notes.
11	Koteswara Rao	Homeopathic physician, SRI activist mentioned in Uphoff's 2004 AP field trip.
12	Sapay Srirammurthy	Invented the marker for use in AP modified since through adaptations.
13	Santosh Koulgi	Organic farmer from Karnataka, brought a pamphlet in 2002 on SRI, innovated on farm and popularised the use of 'ghentu' for weeding.
14	Perumal	Practised wider spacing in Alandur, TN and his experiments featured in article on SRI on the net.
15	Dwarakanath	One of the silent champions of SRI in Karnataka. An ex Vice Chancellor of the agricultural university he has got the government interested in SRI and enabled change of practices by making scientists learn from farmers.
16	Norman Uphoff	Though an American academic, an important part of the Indian SRI innovation system, the champion who spread SRI outside Madagascar and keenly supports new information and knowledge on SRI. Instrumental in promoting and placing Indian SRI in world events.
17	Dinesh Kumar	One of the first to start SRI in AP at the Timbaktu Collective. Realised its pro-poor potential despite his and the organisation's focus on millets and not rice. Now experimenting with spacing options in other crops.

		Groups/Networks
1	All-India Association of Organic Farmers	Have taken to SRI given up their interest in organic cultivation.
2	AME Foundation	Agriculture, Man and Ecology a group with several connections and resource centre for organic farming.
3	LEISA network	An organic farming network especially active in Tamil Nadu.
4	Tamilaga Velaan Neervala Niruvanam, Erode	An organic farming network in Tamil Nadu, Selvam part of it.

5	Kisan Forum	A recent forum for farmers in Andhra Pradesh with leading public personalities keen to promote SRI.
6	Green Foundation	An NGO resource centre in Bangalore, experimented with SRI on ragi and uses farmers such as Appaswamy to train other farmers.
7	Jalaspandana AP	A network of farmers' organisations now actively involved with the irrigation department to establish participatory training centres SRI. A SRI farmer field school has been set up.
8	Jaimini Krishikara Balaga	A group of farmers who have been addressed by Appaswamy in Tamil Nadu.
9	Cornell Alumnus	Not formally involved but have invisible promoters of SRI. Most students of Uphoff have fixed meetings with officials of the government, introduced SRI to NGOs such as PRADAN etc. Social capital very high.
10	Water Users Association, Anantaram	The president, KV Rao, an SRI farmer, was keen to promote it amongst members.

		Governmental-Organisations
1	Tank Rehabilitation Project	A project in Pondicherry which has promoted SRI acting as a spur to the agriculture department later.
2	CBMTCPS, Karnataka	The department that has undertaken maximum SRI trials in Karnataka.
3	Dept of Irrigation, Govt of AP	An ambitious programme of covering 100000 hectares in Kharif 2005 in AP is underway with a proposal to train 1000 master farmers. Focus shifted to tank-based areas based on learning in first year.
4	DAAT centres ANGRAU	District Agricultural Advisory and Transfer of Technology Centres involved in field trials and involving farmers towards SRI.
5	WALAMTARI	Water and Land Management Training And Research Institute, of Irrigation department of AP, now involved in training master farmers who would promote SRI in 100,000 acres.

		Non Governmental Organisations
1	Auroville, Pondicherry	Credited with the first experiment on SRI in 1999-2000, accessed material in French.
2	Centre for Indian Knowledge Systems (CIKS)	An organisation that promotes traditional practices in agriculture, member of several networks and currently doing trials one of their farms in Sirkazhi on SRI.
3	Ecoventure	An NGO in Pondicherry headed by Pushpalata promoting SRI with a strong women focus.
4	CSA	Centre for Sustainable Agriculture, keen on promoting sustainable agriculture practices in dryland areas. A partner of WWF in the second phase of the project, trains other organisations in SRI.
5	Gram Vikas	NGO in Karnataka that is involved in SRI
6	MSSRF	MS Swaminathan Research Foundation headed by the noted agricultural scientist Swaminathan, experimented with SRI in biovillage and partly instrumental in pushing it with the govt in Pondicherry.
7	PRADAN	One of the first NGOs to take up SRI, extensive work in West Bengal (Purulia) and Jharkand. Results have shown good incremental yields with a strong pro-poor focus.
8	Ramoji Film City	A private amusement park and Film city outside Hyderabad where experiments on SRI have been on. Strong interest in agriculture.
9	Timbaktu Collective	One of the first NGOs to take up SRI in AP. Large-scale experiment of 400 acres using SRI in rain-starved Anantapur district.
10	Varanasi Foundation	NGO in Karnataka that is involved in SRI.
11	Vivekananda Girijana Samsthe	NGO in Karnataka that is involved in SRI.
12	VOICE trust	NGO in Tamil Nadu that is involved in SRI.
13	WASSAN	Watershed Support Services and Network keen to take up SRI in a big way with community-based organisations in watersheds, brought out a resource booklet in Telugu using farmers' experiences, conducted implements workshops and innovations.

14	WWF Dialogue project	Keen to look at impact that SRI can have on irrigation water demand, initiated a pilot study to ascertain the water-saving potential of SRI in an interesting partnership with ANGRAU in 11 district of AP. Following enthusiasm amongst stakeholders the project extended to another crop, instrumental in getting ICRISAT and IWMI scientists involved and more recently DoRR.
15	NRAFORD	N. R. Reddy and Abhinay Reddy Foundation for Rural Development a Warangal NGO visited by Uphoff in 2003 keen to promote SRI.
16	Sambhav	An organic farming and sustainable agriculture NGO keen on promoting SRI in Orissa since 2005
17	AME Foundation	organisation based at Bangalore, having links with organic groups. Organised a workshop on SRI in October 2006.

		Private Organisations
1	Sathguru management associates	Their MD. Vijayaraghavan set up meetings with high-level govt. officials in AP and Tamil Nadu
2	Narasimha Reddy,	Representative of Ganga-Cauvery Seeds Company who evinced interest in SRI.
3	Nuzvidu Seeds	Managing director of the company saw SRI offers some real advantages for seed multiplication. Willing to pay for widespread dissemination of manuals on soil health as reported by Uphoff in 2003. Alapati Satyanarayana joins the group after retirement from ANGRAU.

		Media
1	Annadata	A popular agricultural journal brought out by the Eenadu group carried several articles on SRI. Many farmers visited stated their source of information in AP to be Annadata and only later the government or NGOs.
2	Asian Biotechnology and Development Review	This journal carried a special issue on Rice in Asia and had no mention of SRI.

3	Eenadu, Andhra Bhoomi, Prajavani, Vijay Karnataka	Regional language newspapers that have featured several SRI articles.
4	ILEIA magazine	Carried articles on SRI creating interest among certain groups.
5	Nature	Carried a controversial article on SRI titled 'feast or famine' which provoked the phrase "Rice Wars' to describe the warring camps of SRI and IRRI scientists.
6	Tefy Saina & CIIFAD	The website hosted in 2002 has played a big role in promoting SRI.
7	The Hindu	English national daily that has featured several news items on SRI and yet carried a controversial piece attributing SRI as an IRRI invention.
8	Indiatogether	A web-based journal that features development issues has featured special articles on SRI.
		Select categories of farmers
		Farmers like Nammalvar, Ramaswamy Selvam who picked this up initially, Farmers involved in trials in first few seasons, farmers practising through the agriculture dept's support including subsidies provided, farmers working with NGOs like AME Foundation, RAASTA, CIKS, farmers who have had repeated trials of SRI, and disadopters - farmers who chose to try and later gave up for other reasons or due to failure.

Note:

The list is by no means comprehensive but meant to indicate the wide range of actors involved in SRI. Several recent actors especially in the last one year have been underreported. The list of farmers is extensive and is not listed here but this in no way should undermine their importance in the spread. They have often been the leaders in extending SRI.

Acronyms

Acronyms	Names of organisations
TNAU	Tamil Nadu Agricultural University, Coimbatore Tamil Nadu
ACRI	Agricultural College and Research Institute, Killikulam
TNRI	Tamil Nadu Rice Research Insitute, Aduthurai, Tamil Nadu
ANGRAU	Acharya N G Ranga Agricultural University, Hyderabad, Andhra Pradesh
CIIFAD	Cornell International Institute for Agriculture and Development, USA
PRI	Plant Research International, Wageningen, Netherlands
ICRISAT	International Crop Research Institute for Semi Arid Tropics, Patancheru, Andhra Pradesh
IWMI	International Water Management Institute South Asia, Patancheru, Andhra Pradesh
IWMI TATA	IWMI Ratan Tata Project, Anand, Gujarat
UAS	University of Agriculture and Sciences, Bangalore
CRRI	Central Rice Research Institute, Cuttack, Orissa
DORR	Directorate of Rice Research, Rajendranagar, Andhra Pradesh
KVK, Undi	Krishi Vigyan Kendra, Undi, West Godavari district Andhra Pradesh

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