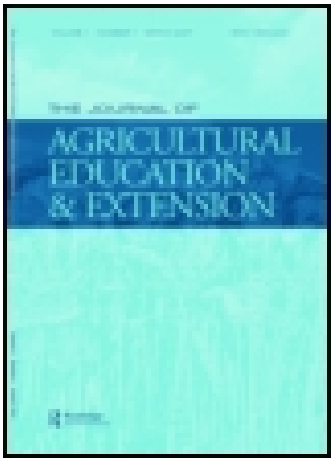

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Agricultural Innovation Systems (AIS): A Study of Stakeholders and their Relations in System of Rice Intensification (SRI)

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Agricultural Innovation Systems (AIS): A Study of Stakeholders and their Relations in System of Rice Intensification (SRI)

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Abstract Purpose: *This paper identifies the stakeholders of System of Rice Intensification (SRI), their roles and actions and the supporting and enabling environment of innovation in the state as the elements of the Agricultural Innovation Systems (AIS) in SRI in Tripura state of India and studies the relationship matrix among the stakeholders.* Methodology: *A descriptive research design was followed to study the agricultural innovation system in SRI. Criterion and expert sampling were employed to select the stakeholders and data was collected by a personal interview method with the help of a semi-structured schedule. Actor Linkage Matrix was employed to study the linkage among the stakeholders in the innovation systems.*
Findings: *The major stakeholders of the innovation systems were the public extension system and the farmers. A unique role of popularization and dissemination of the agricultural technology among the farmers was played by the Panchayati Raj Institutions, the democratic decentralized administrative units at the grass-root level for the dissemination. The relationship between the farmers and the Department of Agriculture, Government of Tripura was found to be strong. The farmers, even though they were primary stakeholders, were not much integrated in the system in decision-making. Media, an important stakeholder for creating awareness, was found to be working independently in the state to create awareness on SRI. The enabling environment for innovation was supported to a great extent by the policies and political and administrative support structures in the state by assisting the farmers in growing rice through SRI.*
Practical Implications: *This paper concentrates on how the integration of stakeholders in the SRI innovation systems has promoted knowledge generation, management, sharing, and learning in SRI, which can be effectively applied in other crops and sectors in India and the developing world.*
Originality: *The paper is one of the very few studies conducted to understand the stakeholders of SRI in the context of Agricultural Innovation Systems in North East India.*

Key Words: AIS, Panchayati Raj institutions, Stakeholders, SRI, North East India, Tripura.

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Introduction

Change is the essence of development. The world is changing fast and so are its needs. Keeping pace is agriculture and agricultural extension, which has changed and evolved till the core all along the way since its inception. As quoted by Jones and Garforth (1997), 'A consistent theme running through the innovative approaches being used, is a fundamental change in what are the respective roles of extension agent and clients. The agent is no longer seen as the expert who has all the useful information and technical solutions; the clients' own knowledge and ingenuity, individually and collectively, are recognised as a major resource'. And so in present times, the focus has shifted away from any particular actor and is rather concentrated on all the potential stakeholders or to be more precise, on Agricultural Innovation Systems (AIS).

Innovation Systems (IS): A Theoretical Background

The concept of innovation dates back to Rogers' definition of innovation as 'an idea, practice or object that is perceived as new by an individual or other unit of adoption' (Rogers 1962). Later, Gibbons et al. (1994) noted that innovation is a fuzzy concept that requires blurring of boundaries in the production of scientific knowledge. The theory of innovation has now developed in to the concept of innovation systems. The concept of 'Systems of Innovation' was first given by Lundvall (1985) who again developed the idea from Friedrich List's (1841) 'The National System of Political Economy.' Chistopher Freeman in his study of the success of Japanese economy coined the term 'National Innovation Systems' (NIS). Freeman (1987) described NIS as a network of institutions in public and private sector, which initiate, import, modify and diffuse new technologies. Lundvall (1992), Nelson (1993) and Patel and Pavitt (1994) limited it within the boundaries of a nation or state. While Metcalfe (1995) emphasised on the socio-political conditions for contributing and influencing innovation process, Hwang and Horowitt (2012) looked at NIS as socio-biological systems of patterns of behaviour to minimise transaction cost caused by social barrier and inefficient social networks.

During the last 20 years, the literature on innovation has shifted from national (Lundvall 1988; Nelson 1993; Edquist 1997) to regional (Asheim and Isaksen 1997) and local (Gottardi, 2000; Garofoli, 2002) dimensions. Regional Innovation Systems (RIS) are complex systems with strong interaction between several actors systematically engaged in interactive learning in which regions can play a central role in economic coordination, especially with impact to innovation, evolving into 'a nexus of learning processes' (Cooke and Morgan 1998; Asheim and Isaksen 2002). Again, regions have been highly heterogeneous concepts which do not always capture factors like regional culture and identity which are more intensively taken into account by local policies (Autio 1997; Lagendijk 2004). According to Belussi (2003), Local Innovation Systems are based on the generation of regionalised learning systems where some local innovation policies are activated to transfer technologies, enforce technological cooperation and provide supports and incentives to innovative networks. Technological Innovation Systems is a concept developed within the concept of IS approach focusing on explaining the nature and rate of technological change and can be defined as a set of actors and roles that influence the spread and direction of technological change in a specific technological innovation area (Hekkert et al. 2007). The most important insight developed from all

these studies is that innovation is a collective activity. The concept of Innovation Systems stresses that the flow of information and technology among people, enterprise and institution is the key to an innovative process and the success of the system depends, to a large extent, on how the innovation system is build up and how it functions (Heimeriks 2013).

Review of Literature

Agricultural Innovation Systems and Its Elements

IS is a network of organisations of varying dynamics (Hall et al. 2006a) and functions (Hekkert et al. 2007) with complex elements that change constantly over time, strongly influenced by the spatial pattern of their components (Hall and Clark 2010). The concept of an innovation system, with its distinctive functions, reveals the institutional factors that govern the relationship of elements and knowledge production in the system (Hall 2006). IS has been identified as exogenous and endogenous—the former being controlled by external agencies and the latter by internal agencies (Assefa et al. 2008).

Various elements of innovation systems have been identified by different authors. It is mainly a social system with interactive learning in the centre and actors and elements which interact in the production surrounding it making a dynamic system (Lundvall 1992). Spielkamp and Vopel (1997) identified R&D agglomeration, human capital, public R&D, policy, demand and competition, financial interrelation, internationalisation, size of firms and industry structure as the elements of National Innovation System (NIS) which with industrial R&D and technology transfer leads to productivity and growth. Balzat and Pyka (2005) identified them as innovative efforts, institutional framework conditions, knowledge base, openness and financial conditions. Again, for corporate innovation systems, the six core elements identified are leadership & management (provides inspiration, makes key choices, and organises the development process), strategic alignment (links innovation strategy with corporate goals, strategy, and objectives), innovation process (defines who does what, when, and how), organisation and people (channel resources, define norms, provide infrastructure, drive innovation), metrics (provide the guidance and control system for innovation) and corporate culture (determines how the above elements behave and interact with each other) (Meyer 1998). In regional innovation systems, industrial clusters, knowledge suppliers, training organisations, financial institutions and industrial associations and institutions are the core elements (Todtling and Kaufmann 1998). According to World Bank (2006), the four elements of innovation systems are key stakeholders and their roles, actors' attitudes and practices, effects and characteristic pattern of interaction and enabling environments.

Role of Stakeholders in AIS

Various stakeholders in an innovation system plays different roles that can be broadly classified as facilitator, communicator, collaborator (Leeuwis 2004; Klerkx and Gilemacher 2012), coordinator (Hall et al. 2006a), knowledge source and networking (Hellin 2012) policy formulator and implementer (Roper et al. 2006). The extension system in an innovation system also has a good chance to come out of its conventional technology

transfer mode to a flexible institution of innovation that changes over time (Hall 2007; Davis and Heemskerk 2012; Rajalahti 2012).

Linkage among Stakeholders and Learning Supported in AIS

The linkage between the stakeholders helps in understanding the relationship between actors in an IS and draws out the strong and weak links in the network (Matsaert 2002; Biggs and Matsaert 2004; Hall 2007; Mohammad et al. 2012). But one glitch in it is that the quality of the relationship or who's who relationship cannot be identified from this tool (Matsaert et al. 2005). The processes of acquiring knowledge and learning in IS are interactive often requiring extensive linkages (Hall et al. 2006b) like partnership, commercial transactions, networks, etc. and these linkages and the relationships that govern them concern knowledge flows in an innovation system (Anonymous 2012). Policy and support structures govern the effectiveness of IS as it sustains and triggers various factors that nurture the system and hence it requires a sensitive policy formulation to bring out the best of IS (Hall et al. 2005, 2006a).

Methodology

The present study was undertaken to identify the elements of Agricultural Innovation Systems (AIS) in System of Rice Intensification (SRI) in Tripura state of India, their role and actions, strength and type of linkages among the stakeholders that support the systems and the enabling environment existing in the state that supports and enables innovation among the stakeholders.

Selection of the Study Area

The study was carried out in the state of Tripura, North East India. The state was selected through criterion sampling (Given 2008) for the following reasons:

(1) Rice is the principle crop of the state covering 78% of the cultivable area and food security heavily depends on rice production, as other cereals are grown by a very limited number of farmers in the state due to food habits and agro-climatic situations (SRI-India 2013).
(2) SRI was introduced in the state in 2001, but demonstrations in farmers' fields picked up in around 2006–2007 and in six years time, the area under SRI has grown from six per cent to 33% of the total area under rice (DoA 2013a). It has seen one of the most extensive extension methods making Tripura one of the leading states in SRI in the country and the leading state in North East India.
(3) Prasad (2007) has quoted 'while a late starter officially with SRI, Tripura has seen a spread of scale with several large-scale contiguous plots (in some cases as much as 65 hectares) not witnessed elsewhere in the country' while Uphoff (2008) has observed that in two years duration, the number of SRI farmers in Tripura has increased from less than 1,000 to more than 70,000.
(4) Even though Tripura is a forerunner in SRI rice cultivation, only a few studies on the socio-economics of the technology in the state have been found after an extensive search on the Internet and books.

Tripura is a small state with average farm size of 0.57 ha and 87% of the farmers being marginal, for their livelihood security, innovations like rubber cultivation and commercial fisheries have been introduced and commercialised in the state. Among the states where SRI was introduced earliest in the country, in Pondicherry and Karnataka it was taken up as a part of Tank Rehabilitation Activities. In Andhra Pradesh and Tamil Nadu, SRI was promoted under Integrated Cereal Development Program under the efforts of Department of Agriculture under respective state governments and also by State Agricultural Universities. In Tripura, SRI was taken up solely under the objective of achieving self-sufficiency in rice and was made possible by the tireless efforts of the stakeholders and the enthusiasm of the farmers. This study is an attempt to understand the resources and capabilities that facilitated the rapid expansion of SRI in Tripura. SRI took 34 long years to develop in Madagascar, 16 years to travel from Madagascar to Tripura, but within a very short time of six years the state has become a forerunner in the country, hence the research study was conducted in Tripura.

Description of Study Area

Located in the extreme south west corner of North East region of India, Tripura state is a small sub-tropical state with geographical area of 10,492 sq km. It is surrounded by Bangladesh on three sides and Assam and Mizoram states of India on the other. Of the land 60% is under forest cover inhabited by various tribal communities. Only 27% of the total area of the state is cultivated of which a mere 4% is irrigated. Rice is the principal crop of the state (SRI-India 2013)—both in terms of production and consumption and the livelihood security of a majority of the farmers depends on it. For the study, two out of four districts of the state were selected by criterion sampling, criteria being the highest and lowest area under rice cultivation and SRI. West Tripura district, with all the agricultural research and extension organisation headquarters and the state capital Agartala, has the highest area under rice and SRI (42% of the total SRI area). Dhalai Tripura has been identified by government as one of the country's 250 most backward districts and is currently receiving funds from Backward Regions Grant Fund (BRGF) Program. This district has the lowest area under rice and SRI (7% of the total SRI area) in the state. Rice being the principle crop of the state, it is cultivated in three seasons—*Aush* (April – June), *Aman* (July – November) and *Boro* (December – March). While in West Tripura rice is preferably cultivated in *Aman* and *Boro*, in Dhalai Tripura *Aush* and *Aman* are preferred due to scarcity of water in *Boro*.

Selection of Stakeholders

For the study, the extension organisations in the state working on SRI were selected by criterion and expert sampling for the study after discussion with key communicators (agricultural extension officers, village level workers, Panchayat heads and contact farmers of Department of Agriculture) from the Department of Agriculture, Panchayati Raj Institutions (PRIs), the decentralised administrative units at grassroots level, and farmers. Selection of farmers were done by criterion sampling after consultation with key communicators from Department of Agriculture, Government of Tripura, Gram Pradhans (Village Panchayat heads), and contact farmers of the state department. For collection of

data, six stakeholder organisations were studied from each district along with 66 farmers. The total number of respondents interviewed for the study was 114 (Figure 1).

Data Collection

Data was collected with the help of a pre-structured interview schedule prepared by consultation with experts from College of Post Graduate Studies, Central Agricultural University, Meghalaya, India and Department of Agriculture, Government of Tripura and modified after a pilot study conducted in a non-sampling area. Each selected respondent was personally contacted and interviewed with the help of interview schedule. It was made sure that the questions were correctly understood by the respondent by repeating the questions wherever necessary. Focus group discussions were also conducted whenever necessary.

Data Analysis

The elements of the SRI innovation system identified in the SRI innovation systems in Tripura are the stakeholders, their roles and actions and the supporting and enabling environment for innovation. The stakeholders were identified by discussion with key informants and focus group discussions. Their roles and actions were studied from the data collected with the interview schedule.

For understanding the linkage among the stakeholders, an Actor Linkage Matrix (ALM) was used. ALM helps to identify all the actors and shows the links between the major actors in the innovation system. The cells in the matrix represent the strength of

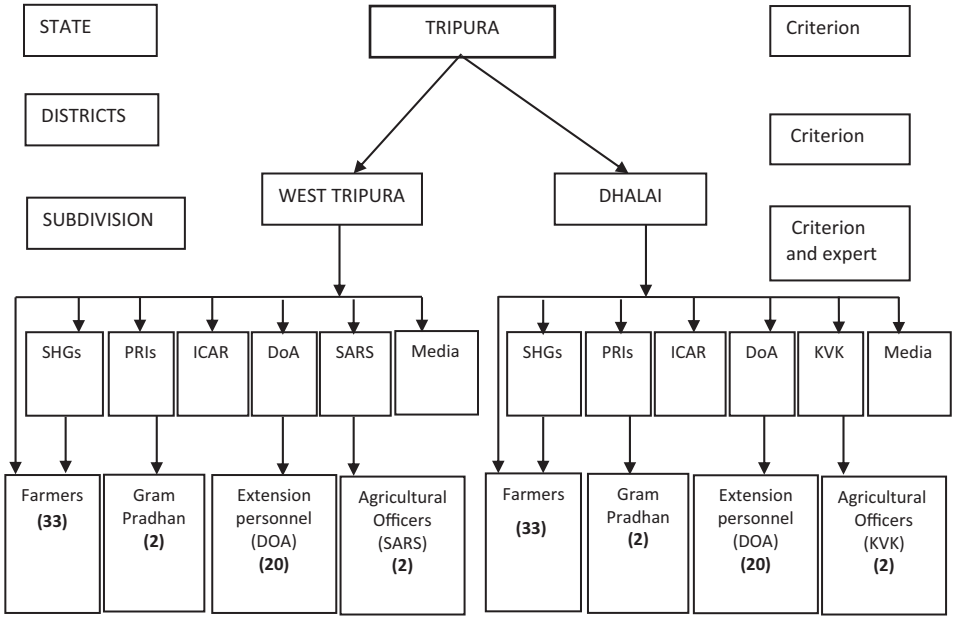

Figure 1. Sampling plan for the study.

relationships between the actors and helps in pinpointing particularly significant links among actors in the innovation system. It can be used to gain an understanding of the key institutional linkages with which the innovation systems should work, or strengthen, to achieve the aims. Type of linkage between actors was studied to distinguish between the links of different actors among themselves. Type of learning was studied to understand how they support the innovation system. The type of linkage and type of learning was studied following the framework given by Hall et al. (2006b).

The policy and support structures are studied to understand the creation of a positive or negative atmosphere to help enhance or degrade an innovative atmosphere in innovation systems. For the present study, the policy and support structures were studied from both primary and secondary data.

Findings and Discussion

Typology of Stakeholders

The stakeholders of SRI innovation systems identified during the study are discussed below (Table 1).

The public organisations, farmers and media have been the main stakeholders of SRI innovation systems in the state. The Department of Agriculture, Government of Tripura (DoA, GoT) has been the lead actor in the system with technical support from Directorate of Rice Research (DRR), Andhra Pradesh, India and financial and policy support from Ministry of Agriculture, Government of India. DoA, GoT looks after the agricultural aspects of the state. Agriculture being a state subject, all the developments and reforms in the sector are being taken care of by the department headed by the Minister of Agriculture of the state of Tripura.

DRR, established by Indian Council of Agricultural Research (ICAR) is an apex body in rice research in the country and mainly coordinates multi-location testing at national level to identify appropriate varietal and management technologies for all the rice ecosystems and conducts various strategic and applied research in the major thrust areas of irrigated rice aimed at enhancement of production, productivity and profitability and at preserving environmental quality (DRR 2013).

The Ministry of Agriculture, headed by the Minister of Agriculture is an apex body under the Government of India. It mainly deals with formulation and administration of the rules and regulations and laws relating to agriculture in India.

The State Agricultural Research Station (SARS), Government of Tripura, has mostly been involved in research and providing technical support to the extension personnel. The main objective of SARS is to disseminate the modern technology among the farming community of Tripura by carrying out research works. In view of its significant contribution towards the rice research and development it has become a voluntary centre of All India Coordinated Rice Improvement Programme. (DoA 2013b).

The Indian Council of Agricultural Research (ICAR) is an autonomous organisation under the Department of Agricultural Research and Education (DARE), Ministry of Agriculture, Government of India. The Council is the apex body for coordinating, guiding and managing research and education in agriculture including horticulture, fisheries and animal sciences in the entire country. The ICAR Research Complex for North East Hill Region, Tripura Centre was established in the year 1975 with a mandate to provide an

Table 1. Typology of stakeholders in the SRI innovation systems in Tripura

Public	Farmers and their collectives	Media
• Ministry of Agriculture, Government of India (MoA, GoI) • Directorate of Rice Research, Hyderabad (DRR) • Indian Council of Agricultural Research – Research Complex for North East Hill Region, Tripura Centre (ICAR-RC for NEH Region, Tripura Centre) • Department of Agriculture, Government of Tripura (DoA, GoT) • State Agricultural Research Station, DoA, GoT • Panchayati Raj Institutions (PRIs) • Farm Science Centre [Krishi Vigyan Kendra (KVK)]	• Farmers • Self help groups	• Local newspapers (Daily Desher Katha and Dainik Sambad) • Radio (Akashvani Agartala) • Local and national television (Doordarshan Kendra, Agartala; e-TV Bangla; Bangladesh Television)

adequate research base in agriculture, horticulture, fisheries and animal husbandry for collection and preservation of cultivated or wild germplasm in crops, animals and fisheries for their subsequent utilisation in improvement programme and dissemination to the farming community (ICAR-RC for NEH Region, Tripura Centre 2013). ICAR-RC, Tripura Centre has looked after the research and extension functions in SRI for three to four years since 2006–2007 and is currently conducting research and promoting Integrated Crop Management (ICM) in the state, a whole farm approach which includes practices that avoid waste, enhance energy efficiency and minimise pollution by combining the best of modern technology with some basic principles of good farming practices and is a long-term strategy.

The Panchayati Raj system in Tripura is guided by the Tripura Panchayat Act 1983 and after the 73rd Amendment Act was brought in, the government enacted the Tripura Panchayat Act 1993. It provided a three-tier Panchayati Raj structure with *Gram Panchayat* at the village, *Panchayat Samiti* at the block and *Zilla Parishad* at the district levels. Gram Panchayats are constituted below the block level and consist of a number of constituencies called Wards. The Panchayati Raj Institutions (PRIs) are mandated with the responsibility for preparation of plans for economic development and social justice, and its agency functions relate to the implementation of schemes for economic development and social justice (Tripurainfo 2013).

Farm Science Centre, Dhalai under the host organisation Directorate of Agriculture, Government of Tripura was established in 2011 in the district. The Farm Science Centre gets its human resource from the Department of Agriculture whereas technical and financial support from ICAR-RC for NEH Region, Meghalaya, India.

Tripura's economy is mostly dependent on agriculture and so the farmers play a major role in agricultural innovation and as such, farmers have been the most important stakeholders of SRI in the state. Even though they have been basically at the receiving end of the technology, but their enthusiasm and ready acceptance has made SRI a big success in the state. The farmers' collectives are the Self Help Groups formed by the department under Registered Seed Growers Program. These groups produce rice seeds which the Government buys from them at Rs. 12 per kg and sell to the SRI farmers at subsidised rates at Rs. 6 per kg.

Media in Tripura has an active role in agricultural information dissemination. The two major newspapers of the state have a dedicated page on a weekday (*Daily Desher Katha* on Saturday and *Dainik Sambad* on Wednesday) on agriculture whereas electronic media like TV and radio have also been playing an important role with their agricultural programmes. While Doordarshan Kendra (Agartala) telecasts agricultural programmes ('Krishi Darshan') Monday to Friday from 6–6.30pm, Akashvani Agartala broadcasts their programmes 'Chasher Katha' (Farmers' story) everyday from 6.45–7am and 12.55–1.15pm and 'Baro Grihastir Ashar' (Rural Family Program) daily from 6.30–7pm.

Role of Stakeholders

The major roles played by the stakeholders are tabulated (Table 2) and discussed below.

Major role played by the MoA was of funding source (through National Agriculture Development Scheme (NADS) at Rs. 3918 per hectare per farmer, National Food Security Mission (NFSM) at Rs. 7000 per hectare for 10 hectare continuous plot

Table 2. Role of stakeholders in SRI innovation systems in Tripura perceived by extension personnel and farmers (n = 108)

Stakeholders	Role	Frequency
MoA, GoI	Funding	106
	Policy formulation	73
	Facilitator	20
	Coordinator (West Tripura)	3
	Policy implementer (West Tripura)	1
	Collaborator (West Tripura)	1
DRR	No role	90
	Research	15
	Transfer of Technology (Dhalai)	4
ICAR-RC for NEH Region, Tripura Centre	Research	49
	Policy implementation	36
	Transfer of technology	32
	Awareness	24
	Facilitator (West Tripura)	2
	No role (West Tripura)	2
DoA, GoT	Funding	91
	Policy implementation	77
	Policy formulation	76
	Facilitator	60
	Awareness	47
	Market linkage	25
	Transfer of technology	21
	Coordinator (West Tripura)	8
	Research (West Tripura)	3
	Collaborator (West Tripura)	3
SARS	Research	54
	Policy formulator	16
	Policy implementation	13
	Awareness	8
Farm Science Centre[a]	Transfer of Technology	54
	Policy implementation	40
	Research	28
	Awareness	17
	Policy formulation	12
PRIs	Collaborator	51
	Awareness	40
	Coordinator	33
	Transfer of technology	24
	Policy implementation (West Tripura)	23
Self help groups	Receiver of technology	104
	Policy implementer (West Tripura)	16
Farmer	Receiver of technology	108
Media	Awareness	97
	Transfer of technology (West Tripura)	4
	No role (Dhalai)	9

Note: [a]Farm Science Centre is present only in Dhalai while SARS is located in the West Tripura.

of SRI and Macro Management in Agriculture (MMA) Scheme at Rs. 2500 per ha. for demonstration) and policy formulator (NADS, NFSM, MMA under which SRI is being promoted in the state) for the SRI innovation system in the state.

DRR, being a research organisation, provided technical help, but did not have any major role to play in the SRI innovation system, as it is connected only through the agricultural officers of DoA, GoT and majority of extension personnel working at the village level and the farmers had no idea about the organisation. The role of DRR is limited to the research-extension linkage in Tripura though in states like Tamil Nadu DRR has conducted demonstrations and On Farm Trial on SRI (DRR 2009). The organisation is not directly linked to the farmers of the state but through the DOA.

The major role of ICAR-RC for NEH Region, Tripura Centre in the innovation systems has been as a research organisation, but it has also been involved in implementation of MMA, NADS and the state plan in collaboration with DoA, GoT and creating awareness among the farmers on SRI through awareness programmes, meetings and training conducted. ICAR-RC Tripura Centre, being primarily a research institute, is more involved in development and/or release of rice varieties suitable for conditions in Tripura and also in ICM, and hence is presently not much active in SRI.

DoA, GoT as the lead stakeholder of SRI innovation system in the state, played multiple roles as formulator and implementer of different policies, programmes and schemes; funding for dissemination and adoption of the technology; awareness creation among the farmers, political dignitaries, village level administrators, facilitator, transfer of technology, market linkage, coordinator, researcher and collaborator.

SARS has been a pioneer in SRI in Tripura. SRI was introduced in the state through SARS and since then it has played some major roles in its dissemination. Research is the main agenda of SARS along with policy formulation in collaboration with the planning section of DoA, GoT and implementation of various schemes under the perspective plan and state plan and creating awareness among farmers to some extent.

Functions of the Farm Science Centre have been implementation of NADS, NFSM and also under Agricultural Technology Management Agency (ATMA); trials on varietal performance of hybrid paddy under Dhalai agro-climatic condition under upland irrigated condition; creating awareness among the farmers about SRI and policy formulation to some extent.

The PRIs work with the DoA, GoT to popularise SRI by conducting awareness programmes in the villages in partnership with the department. The PRIs also monitor the status of farmers and act as a connection between the farmers and the DoA by addressing the issues of the farmers in the monthly meeting with the officials of DoA. PRIs coordinate the awareness programmes on behalf of the DoA, ICAR-RC for NEH Region, Tripura Centre or Farm Science Centre, help the department in selecting the beneficiaries for the schemes of SRI and also partner in disbursement of the funds under various schemes to help the farmers.

In Tripura, at present there are no SHGs on SRI specifically but groups of registered seed producers of rice and other crops under Registered Seed Growers Program. These groups are formed by the DoA for producing seeds under the supervision of department officials and their works are closely monitored. So the groups are believed to have no significant functions in the agricultural innovation systems in SRI. The group members themselves think they don't have any role; rather they are the beneficiaries in the SRI innovation system. But some of them believe to have the role of policy implementers since they grow seeds under NADS, the state plan and the perspective plan. The farmers, though considered as one of the most important stakeholders of SRI in the state, are not considered to have any prominent role in the innovation systems. They are rather thought

of as beneficiaries who lie at the receiving end of the system. But among them, transfer of technology is an important role played as most of the farmers have informal meetings in their villages among friends or neighbours twice to thrice a week, where they exchange information among themselves.

Media has played an important role in creating awareness among the farmers and the people about SRI. Not only that, but the continuous reporting of the technology and the success stories removed the scepticism about the sustainable high yields of SRI from the minds of the farmers and professionals alike. Media in the state have worked independently on professional interest. They generally publish or broadcast reports about the timings of disease and pest outbreaks much ahead of time making the farmers aware. These kinds of information are not always available from the extension personnel. But few farmers (30%) of Dhalai district believed that media do not play any role in SRI or farming for that matter, as they can get all the important information they need to know from the extension personnel of DoA and neither do they have time to watch TV, listen to the radio or read newspaper after working 10–12 hours on the farm.

Actions of Stakeholders

Major actions of the stakeholders in Tripura state India are discussed below (Table 3).

MoA, GoI ensures that different activities are taking place and the funds allocated to the state under projects and schemes like NADS, NFSM, MMA are put to right use in the right place through monitoring and evaluation and the monthly progress reports and the yearly report at the end of the financial year submitted by the Department of Agriculture to the Ministry notifying the distribution and utilisation of funds; works for policy changes (NFSM-Rice, NADS, ATMA) and schemes (MMA) to develop an enabling environment for innovation by assisting the DoA in extension and farmers in adoption; gives financial help under different schemes and policies directly or indirectly related to SRI. Under MMA, Tripura received 100% funding from the state in the financial year 2012–2013 and Rs. 1078.89 lakhs from the Ministry of Agriculture under NFSM-Rice (DAC 2013). To some extent the Ministry plays a role in creating a linkage between different actors like DoA, ICAR-RC for NEH Region, Tripura Centre, DRR and Panchayati Raj Institutions.

DRR is considered to be mainly involved in research and to some extent related to capacity-building of extension personnel by providing them with technical help regarding agronomic practices of SRI and their scientific explanations. The DoA also keeps contact with DRR to get better acquainted with the agronomic and technological aspects of SRI. But most of the farmers of the state had no idea about the organisation as they don't have any direct link to it.

ICAR-RC for NEH Region, Tripura Centre has been disseminating new and old information about rice cultivation in general to the farmers to create awareness among them. ICAR-RC for NEH Region Tripura Centre has initiated visits of high officials in agriculture to the demonstration plots in farmers' field to encourage them (ICAR-RC for NEH Region, Tripura Centre 2010). But since they were not active anymore, some farmers in both the districts said even though they have heard about the organisation, they do not have any clear idea about its actions taken regarding SRI.

DoA has been ensuring the proper implementation and working of all the policies both by MoA and DoA; technology transfer to farmers through training, workshops, meetings,

Table 3. Actions performed by stakeholders in SRI innovation systems (n = 108)

Stakeholders	Actions	Frequency
MoA, GoI	Facilitating	67
	Advocating	37
	Funding (Dhalai)	16
	Brokering (Dhalai)	4
DRR	Research and development	61
	Nil	30
	Coaching	11
	Dissemination (Dhalai)	7
ICAR-RC for NEH Region, Tripura Centre	Dissemination	69
	Coaching	58
	Nil (West Tripura)	3
DoA, GoT	Dissemination	105
	Coaching	102
	Facilitating	96
	Advocating	28
	Brokering	25
	Convening	10
SARS	Research and development	29
	Facilitating	16
	Coaching	16
	Advocating	10
	Dissemination	9
Farm Science Centre[a]	Dissemination	54
	Coaching	49
	Advocating	8
PRIs	Convening (West Tripura)	54
	Coaching (Dhalai)	48
	Advocating (West Tripura)	23
	Mediating	19
SHGs	Dissemination (unrecognised)	104
	Coaching (West Tripura)	4
Farmers	Dissemination (unrecognised)	108
Media	Dissemination	99
	Nil	9

Note: [a]Farm Science Centre is located in Dhalai district whereas SARS is in West Tripura.

etc*;* dissemination of SRI among the farming community through AV presentations in village markets, distributing leaflets in villages, taking farmers for field visits, field demonstrations, continuous meetings with farmers in the villages, organising Farmers Field Schools, etc.; formulating and suggesting important policies and programmes for creating a supportive environment for the farmers to adopt the innovation.

Major actions of SARS have been facilitating the farmers especially to provide them all the necessities to adopt SRI; coaching extension personnel and farmers on the agronomic practices of SRI; formulating new policies or bringing changes in the old ones related to SRI, but research and development has been given the first priority by SARS for popularisation of SRI in the state.

Farm Science Centre, Dhalai has been mainly involved with disseminating the technology to the farmers; coaching the farmers about the technological aspects of SRI

and trying to make them understand the basics behind the principles so as to help the farmers to make their own modifications in the method suited to their own conditions and advocating for relevant changes in policies both at state and local government level to give the farmers a better scope at farming and also to fight food insecurity in the state in the long run.

PRIs have been convening promotional programmes like awareness programmes, trainings, workshops, field visits, etc., at local levels being well connected to both farmers and the DoA; advocating for policy changes for a supportive atmosphere in SRI and mediating between the administration at higher level and the farmers and tried to solve the problem of farmers and increased the efficiency of the DoA by increasing dialogue between the two stakeholders.

The self help groups [Registered Seed Growers (RSGs)] are more involved with implementation of technology and they are seen more as beneficiaries than benefactors and hence they are not considered to have much significant role or action in the innovation system. But according to some farmers, coaching is an action of the self help groups though it is more informal than formal. Since the RSGs follow the principles strictly and are monitored by the department regularly, they work as reference points to other farmers who often turn to them for advice.

The farmers of the state are considered by both extension personnel and farmers themselves as important stakeholders in SRI innovation systems, but they did not play any prominent role as such. But during the interview, dissemination of information and technology among themselves was found to be a very important role of the farmers, but it was unrecognised as they do not consider it as a specific action as they had been doing that since time immemorial. The farmers in the villages very frequently sit together and discuss various aspects of farming and in the process disseminate information and influence each other and according to the extension personnel it played quite an important role in dissemination of the technology. Other than that, the farmers were mostly considered as receiver of technology by both the extension personnel and farmers themselves and do not have any prominent action otherwise.

Dissemination of information on SRI has been the most important action of media in the SRI innovation system in Tripura. Since the introduction of SRI in the state, media has been independently publishing and broadcasting reports on success of SRI in farmers' field, interviews with extension personnel and successful farmers and inspiring others. The extension personnel reported that ICAR-RC for NEH Region, Tripura Centre was also convinced and influenced to some extent by media reports of the success of SRI in Tripura. But 15% of farmers believed that media has no important action in the SRI innovation system in the state. They reported they do not access media for information on SRI, as they do not find it credible.

Linkage among Actors in the Innovation System

The actor linkage matrix of the actors in SRI innovation systems in two selected districts of Tripura revealed DoA as the lead link Table 4 and 5. The department has been sharing a fair relationship with the MoA, which is mainly guided by policy implementation. While the department personnel had a poor relationship with DRR in West Tripura, in Dhalai they had a fair relationship with the organisation. Similarly, with ICAR-RC for NEH Region, Tripura Centre, the department had a poor relation in West Tripura due to

non-involvement of the former in SRI in recent times. ICAR-RC for NEH Region, Tripura Centre is more involved in ICM and varietal research and breeding programmes of various plants and livestock, hence not much involved in SRI. In Dhalai, ICAR-RC for NEH Region, Tripura Centre had been collaborating with the Farm Science Centre and through it, the relationship of DoA was fair with ICAR-RC for NEH Region, Tripura Centre. While intra-organisational linkage is very efficient in the department, it also shares a good relationship with the research wing (SARS). The department had a fair relationship with the PRIs as through them they received the list of beneficiaries of SRI every cropping season. It helped the department in fulfilling its targets and the expansion of SRI in farmers' field also becomes easier. The department had a good relationship with the SHGs in West Tripura but fair in Dhalai. This is so because the numbers of SHGs in West Tripura were much higher than in Dhalai. The DoA has been maintaining a very good relationship with the SRI farmers through the extension functionaries and has been taking care of their information and resource needs. The DoA has a poor relationship with the media as the media does its work independently and the DoA has its own extension methods to create awareness.

The farmers received strong information support from the department, other farmers and the PRIs and medium support from the SHGs. The farmers had poor relationship with ICAR-RC for NEH Region, Tripura Centre and SARS. In the village, the village level workers are considered as the most credible source of information on SRI and the farmers depended on them for all their information needs. Other than that, they also receive assistance from the extension personnel of Department of Agriculture, Government of Tripura. Since the Panchayat selects beneficiaries for SRI, the farmers stay in close contact with the Panchayat for any assistance and also for other necessities like subsidised machineries for intercultural operations, pump sets for irrigation, etc. Other than that, every three to four days in a week the farmers sit together in informal gatherings in the villages and exchange information among them. Farmers of Dhalai shared a good relationship with the Farm Science Centre as the personnel visited the farmers' field once or twice a week and kept in touch with them. But farmers of West Tripura district did not have any direct link with the SARS, which was more closely involved with the extension personnel.

Since the study was conducted in Tripura and due to limitation of resources, the Ministry of Agriculture, GoI, New Delhi and Directorate of Rice Research, Hyderabad, Andhra Pradesh could not be contacted as both the stakeholders are located outside the state. Moreover, there was no specific official identified during focus group discussions from either organisation who were responsible for all matters related to SRI in Tripura. ICAR-RC for NEH Region, Tripura Centre officials, when contacted, said they were not working on SRI anymore and so could not provide any information. Media is working on their own for public interest and even though through publications and broadcasts has become a stakeholder, but does not have any links as such with any of the other stakeholders in the state.

The numbers in the cells are the scores to indicate the strength of relationship among the stakeholders and are entered horizontally in the cells against each stakeholder. Since there is difference in perception among different stakeholder about the strength of their relationship amongst each other, the scores varies with the individual stakeholder.

Table 4. Actor linkage matrix in West Tripura district

	MoA	DRR	ICAR-RC for NEH Region, Tripura Centre	DoA	SARS	PRIs	SHGs	Farmers	Media
MoA	X								
DRR		X							
ICAR-RC for NEH Region, Tripura Centre			X						
DoA	1.83	0.29	0.86	X	3.1	1.62	2.73	4	0.29
SARS	4	2	0	4	X	3.5	3	4	2
PRI	0	0	0	4	4	X	2	4	0
SHGs	0	0	0.1	4	2	4	X	4	0
Farmers	0	0	0.1	4	0.5	4	2	X	0
Media									X

Note: 0 = no relation; 0.1–1 = poor; 1.1–2 = fair; 2.1–3 = good; 3.1–4 = very good; blank cells = don't know.

Table 5. Actor linkage matrix in Dhalai Tripura district

	MoA	DRR	ICAR-RC for NEH Region, Tripura Centre	DoA	Farm Science Centre	PRIs	SHGs	Farmers	Media
MoA	X								
DRR		X							
ICAR-RC for NEH Region, Tripura Centre			X						
DoA	1.8	0	1.5	X	4	4	1.1	4	0
Farm Science Centre	0	1.5	4	4	X	4	1	4	0
PRI	0	0	0	4	4	X	4	4	0
SHGs	0	0	1	4	1	4	X	4	0
Farmers	0	0	1	3.4	4	4	4	X	0
Media									X

Note: 0 = no relation; 0.1–1 = poor; 1.1–2 = fair; 2.1–3 = good; 3.1–4 = very good; blank cells = don't know.

Typology of Linkage and Type of Learning

An analysis on the type of linkages between the stakeholders is important as it helps to distinguish between different types of linkages and identifies the ones important for

learning and innovation (Hall et al. 2006a). The type of linkages has been studied by the typology given by Hall et al. (2006a).

The stakeholders of SRI innovation systems in the state mostly are partners and alliances that work hand in hand to foster the innovation system and gave it a conductive atmosphere for growth. Stakeholders like farmers and SHGs share a paternalistic linkage, which supports technology transfer mainly by formal means of trainings, etc. The types of learning existing in the innovation system are mostly interactive which fosters an environment of growth and is the most expected type of learning in an innovation system.

The stakeholders of SRI innovation systems in the state mostly are partners that work hand in hand to foster the innovation system and give it a conducive atmosphere for supporting innovation in SRI. Stakeholders like farmers and SHGs share a paternalistic linkage with extension and research institutes, which support technology transfer mainly by formal means of training, etc. The DoA and other policy-implementing stakeholders share an alliance among themselves which helps them to learn from each other. None of the stakeholders had any kind of formal links with the media, which is an independent but important entity of the innovation system as it has been creating awareness among the extension personnel and farmers alike (Table 6).

The type of linkage that existed between the stakeholders decided to a large extent the type of learning between them. The right type of learning is encouraged by right kind of relationship that exists. For example, while in a partnership or alliance the flow of information will be two directional and interactive, in a paternalistic relationship the flow of information is unidirectional irrespective of the needs of the receiving party. In Tripura, it was mostly interactive type of learning among the research and extension institutes and organisations whereas with farmers it was learning by imitating and mastering and learning by training. Among the farmers, SHGs and PRIs, it was interactive learning. This made the relationship between the actors stronger and conducive to positive changes, which made SRI a successful social innovation in the state. This finding can be backed by the observation of Hall et al. (2006a) that it is important for the right type of linkage to exist in the right place in an innovation system and successful innovation system tend to have linkages that support interactive relationships (Table 7).

Policy and Support Structure

SRI promotion in the Tripura has been guided by various policy supports from both the state and central governments. The major policies that have positively impacted the promotion of SRI in the state by assisting the extension personnel and farmers alike are Macro Management in Agriculture Scheme (MMS), National Agriculture Development Scheme (NADS) and National Food Security Mission (NFSM) of Central Government and Perspective Plan of the State Government.

The Macro Management of Agriculture Scheme is one of the centrally-sponsored schemes formulated with the objective to ensure that central assistance is spent on focused and specific interventions for the development of agriculture in the country. It became operational in 2000–2001 in all states and Union Territories (UTs). The scheme provides sufficient flexibility to the states to develop and pursue the programmes on the basis of their regional priorities. Thus, the states have a free hand to finalise their sector-wise allocation as per requirements of their developmental priorities (DAC 2013). The pattern of assistance of the scheme is 90:10 by central and state governments except in North-Eastern states where it

Table 6. Type of linkage among stakeholders in SRI innovation systems

	MoA, GoI	DRR	ICAR-RC for NEH Region, Tripura Centre	DoA, GoT	SARS	Farm Science Centre	PRIs	SHGs	Farmers	Media
MoA, GoI	X									
DRR		X								
ICAR-RC for NEH Region, Tripura Centre			X							
DoA, GoT	1, 2	2, 3	2, 4, 5	X	2, 6	2	1, 4	5, 6	5, 6	–
SARS	1	3	0	2, 4	X	–	5	5, 6	6	6
Farm Science Centre	1, 2	3	3, 5	2	–	X	1, 4	5, 6	5, 6	0
PRIs	0	0	2	1, 4, 5	7	1, 4	X	6	6	0
SHGs	0	0	7	1, 6	7	7	6	X	6	0
Farmers	0	0	7	1, 6	7	6, 7	6	6	X	0
Media										X

Note: 1 = Advocacy linkage, 2 = Partnership, 3 = Network, 4 = Alliance, 5 = Paternalistic, 6 = Information exchange, 7 = Formal contract.

Table 7. Types of learning among the stakeholders in SRI innovation systems in Tripura

	MoA, GoI	DRR	ICAR-RC for NEH Region, Tripura Centre	DoA, GoT	SARS	Farm Science Centre	PRIs	SHGs	Farmers	Media
MoA, GoI	X									
DRR		X								
ICAR-RC for NEH Region, Tripura Centre			X							
DoA, GoT	A	A	A, B	X	A	A	A	A, C	A	–
SARS	A	A	–	A, B	X		C	A, C	A	A
Farm Science Centre	A	A	A, C	A		X	A	A, C	A, C	–
PRIs	–	–	A	C	D	A	X	A	A	–
SHGs	–	–	D	A	D	D	A	X	A	–
Farmers	–	–	D	A	D	A, D	A	A	X	–
Media										X

Note: A = Interactive; B = Learning by doing; C = Learning by training.

is 100% centrally funded. During the initial stages of SRI in the state, the fund for research and promotion was received from MMA until NADS funds were allocated for the purpose in the year 2008–2009.

The National Agriculture Development Scheme (NADS) of Additional Central Assistance was launched on August 2007 as a part of the 11th Five Year Plan with the goal to achieve 4% annual growth in agriculture through development of agriculture and allied sectors during the plan period from 2007–2011. A part of the NADS fund in Tripura is directed to assist the marginal and small SRI farmers in Tripura. A total of Rs. 3916 is given to each beneficiary farmer who opted for SRI cultivation both in cash and kind under the scheme.

The centrally sponsored scheme 'National Food Security Mission' was launched in the financial year 2007–2008 to operationalise the resolution of the National Development Council (NDC) in its 53rd Annual Meeting in 2007 to launch a food security mission comprising of rice, wheat and pulses and increase their production by 10, 8 and 2 million tonnes respectively by the end of the 11th Five Year Plan (2011–2012) (MoA 2013). In order to cover more area/region of the country keeping in view the recommendations of the Committee of Agriculture on Demand for Grants, the National Food Security Mission-Rice (NFSM-Rice) has been extended from 16 states to 24 states from the year 2012–2013 including Tripura (PIB 2012). In Tripura, the NFSM fund is being utilised for SRI since 2011–2012 Boro season. The assistance provided under NFSM is ′ 7000 per hectare for one unit SRI farm (1 unit=10 ha). The beneficiaries in the state are separate for NADS and NFSM who are chosen by the Gram Panchayat.

The Department of Agriculture, Government of Tripura implemented the Perspective Plan in the financial year 2000–2001. The main aim of the plan was to achieve food self sufficiency in food grains by the year 2010 by: (i) increasing production through area expansion and (ii) increasing production through productivity enhancement. The mid-term review of the plan in 2004–2005 brought down the target of food grain production from 10.88 lakhs tonnes to 8.22 lakhs tonnes due to reduction in population growth. SRI got special mention in the mid-term review of the plan for attaining self-sufficiency in food grains. Again, during the review of perspective plan in 2008 by the Council of Ministers, SRI was specially mentioned and the support structures were strengthened to help the farmers grow rice by SRI. During 2009, the perspective plan and its achievements were reviewed by the chief minister and the plan period was extended until 2011–2012. For SRI specifically, the aim was to increase the area to 1 lakh ha by 2011–2012. Assistance was to be given at reduced level for critical inputs like chemical fertilisers, bio-fertilisers, etc. amounting to Rs. 1650 per ha (Rupees 1650 only) against the existing level of Rs. 3916 per ha. A village level register was decided to be maintained to identify the laggard farmers and focus maximum extension effort towards them to minimise their yield gap by encouraging them to adopt advanced techniques like SRI (DoA 2010). As per the report of the department, there has been an increase in productivity of rice by 1722 kg per hectare (978 kg/ha in 1971–1972 to 2700 kg/ha in 2011–2012) under the perspective plan (DoA 2012).

All these policies and schemes were implemented to have a positive effect on SRI in the state and as expected, have boosted the promotion of SRI in the state to a great extent. But along with these, there have been a few schemes and policies that have had a negative impact on SRI farmers. One of them is Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS). Under this scheme, the unemployed rural

people are given 100 days work a year under various sectors. But according to the interviewed farmers' opinion, due to MGNREGS, getting labour during transplanting or harvesting is very difficult, as they prefer to go for MGNREGS work. The farmers noted that the daily wage of labour is also very high (Rs. 250/day for men and Rs. 200/day for women) for agricultural purposes, which takes away a large part of their profit. And in cases when they have the money, getting labour is again a problem since most of the daily labours are engaged in MGNREGS. In some agricultural subdivisions, the MGNREGS labours are engaged in SRI fields during labour intensive operations but that is not the story of most of the subdivisions. Another constraint is the very low price of rice in the state. The price of rice rarely fluctuates and it is much lower compared to some other neighbouring states, which puts the farmers in loss. All these factors have made rice cultivation not very profitable in the state and some farmers (about 36% of the respondents) are discouraged to take up rice cultivation and are switching to vegetable cultivation due to the profit. But all in all, efforts are being made to make it as supportive as possible for the farmers. It is what Hall and Clark (2010) has also observed, 'The best that policy can do is to look for promising generic tactics and to support adaptive behaviour'.

Conclusion

SRI in Tripura has been a mass movement that brought about not only agricultural, but social change in the rural areas. The rice farmers who were thinking of giving up farming and taking up any other profession are returning to rice cultivation with more enthusiasm than before. This has been made possible by the constant interaction of research, extension and farmers, and by making the system conducive by proper policy implementation. The SRI innovation systems in the state has nearly fulfilled its target of attaining food sufficiency and has provided a secure livelihood to the rural farming households, but the organisations of rural stakeholders in the systems were less than necessary. While an enabling environment has played big role in the success of SRI in the state and measures for capacity-building have taken the stakeholders forward by hand-holding, the interventions for further linkage with a wider network have been absent in the systems and farmers suffered for lack of market linkage.

Extension has been the central component in the innovation systems; with the right attitudes and relationships in the right place it has nurtured the systems. The role played by democratic administrative units—the PRIs has been unique in the state in dissemination of an agricultural technology. The dissemination of SRI has gained momentum mostly because the responsibility was shared beyond the extension realm—inclusion of local administrative units, research institutions and farmers together made it possible. The policy support at initial level also helped the technology transfer. If not for the higher yield, for the incentives the farmers started SRI and after observing the yield increase and decreased resource use, stuck to it even without the incentives. Integration of stakeholders has promoted knowledge management, sharing, and learning in SRI, which can be effectively applied in other crops and sectors in the state and the country.

In the AIS in SRI in Tripura, each stakeholder played their distinct role with proper cooperation and coordination amongst them. While the research and extension mechanism took extensive care for proper dissemination of SRI, the farmers amongst themselves played a big role in the spread of the practice. Monetary incentives, subsidised inputs

along with other related rural development schemes like establishment of irrigation facilities in the villages, proper road connectivity linking interior villages to markets, have been effective in spreading SRI faster in the state. All the policy measures in the state, the extension mechanism working rigorously motivating the farmers, the local administrative units taking high interest in the development of the farmers and an efficient research system have been the key enabling factors in the state. Replication in other parts of the world in similar or nearly similar situations can make AIS in general and SRI in specific a big success in developing the farmers in a climate smart way.

Policy Implications and Recommendations

The SRI innovation system in Tripura has seen some remarkable alliance among stakeholders that has resulted in the rapid dissemination of the technology around the state. But still, it has got its own lacunas that have prevented the stakeholders to get the benefit of others' expertise. Some steps that can be taken to address these issues are:

(1) ICAR-RC for NEH Region, Tripura Centre, being part of a national institute, has got high credibility among the farmers. So integrating ICAR in dissemination of SRI, in spite of its research mandate can increase the enthusiasm among farmers.
(2) Market linkage has been a role ignored by most of the stakeholders and even though addressed to some extent, it still does not fully satisfy the need of a better market for the farmers. Increasing the involvement of actors in the demand side and creating awareness among farmers to form groups rather than selling to the middlemen can go a long way to increase the profits of the farmers along with the increased production from SRI.
(3) Even though not recognised, but technology transfer among the farmers has played a great role in dissemination of SRI in the state. Recognising the potential of this interchange and increasing the farmer-farmer contact formally though field days, interaction among farmers of different villages and districts can make the spread faster and more efficient when learned from experience.
(4) Media, though acknowledged to have played an important role in the dissemination of SRI in Tripura state of India, has been acting alone in the innovation systems. Since it has got a wide audience in the state, it can prove to be a very effective medium for mass dissemination of technology and to create awareness among the farmers and professionals alike.
(5) Interactive learning and regular two-directional information exchange needs to be increased between the farmers and the leading extension service providers in the state – DoA, GoT, Farm Science Centre and SARS by involving them in policy formulation procedures and taking into view the suggestions and grievances of the farmers or farmer representatives from each village.
(6) Inclusion of private sector in the AIS in SRI can added a greater advantage in the demand side and by establishing post harvest processing units of rice it can diversify the income of the SRI farmers.
(7) SRI techniques are sustainable in nature and are compatible to mitigate losses caused due to variations in climate without affecting the yield much. SRI can be promoted by the government for combating effects of climate change and can be included in policy measures.

(8) The case of Tripura has shown grassroots level administration can be very effective in disseminating a technology and replication in other parts of the developing world with similar conditions, can make technology transfer much easier.
(9) Financial incentives are very important to motivate farmers to take up SRI, but as they become sustainable, the incentives can be reduced along with increase in farmer's income to reduce the burden on the government and increase the self-dependency of farmers.

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