Beyond Technological Solutions

Farmers, water and the introduction of the System of Rice Intensification in the Tambiraparani river basin, Tamil Nadu, India

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MSc Thesis Technology and Agrarian Development (TAD)

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(TAD-80430; 30 ECTS)

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Preface

The famous Tamil poet Tiruvalluvar wrote in his work the Thirukkural, a work of universal thoughts and truths about life; 'the book that never lies', the following two couplets on ‘farming’ and ‘the blessing of rain’:

உழுதுண்டு வாழ்வாரே வாழ்வார்மற் றெல்லாம் 1033
தொழுதுண்டு பின்செல் பவர்

They live, who live to plough and eat;
The rest behind them bow and eat

(Thirukkural, couplet 1033)

நீர்இன்று அமையாது உலகெனின் யார்யார்க்கும் 20
வான்இன்று அமையாது ஒழுக்கு

Water is life that comes from rain;
Sans rain our duties go in vain

(Thirukkural, couplet 20)

Tiruvalluvar wrote his Thirukkural somewhere during the 1st millennium BC, but still his simple two-line poems, displaying the value and way of life, are applicable to the nowadays live. In case of the above two of his truths about farming and rain, this can be confirmed: farmers are able to live freely and deserve respect, as they provide us with food; and our life in the world is impossible without rain/water. Although everyone would logically recognize the value and truth of both these Thirukkural couplets, they seem to be of a more complex conflicting and interrelated nature than one would expect. Especially nowadays on the native soil of the poet who wrote them, Tamil Nadu, where water resources are not sufficient enough to meet the growing demands. As a consequence farmers are facing problems with the cultivation of their crops, especially rice, and the future prospects are even less hopeful. The System of Rice Intensification (SRI) possibly provides new options. The situation and environment of the Tamil Nadu farmers, the problem of limited and irregular availability of water for crop irrigation, and the System of Rice Intensification as a possible solution to the present problems are the main focus of this thesis. Hopefully this research will give a broader insight in the complexity of the farming environment and the problems related to water demand and availability in Tamil Nadu. May it hopefully contribute in some extend to future research and solutions.

For me personally the realization of this thesis was a challenge altogether. First of all my study program is mainly of a technical nature and therefore my knowledge on sociological concepts was limited. But as I believe personally that agricultural problems are not merely solvable through technological concepts but are also for a large part social constructed, I took on the challenge with this thesis to explore both technical and sociological aspects and the interactions between them. Furthermore, I wanted to experience how it would be like to conduct a research on agriculture in a totally different part of the word, in a totally different environment and where different crops are grown, to gain insight in the contrast between the western world's agriculture and that in other parts of the world. These facets were realised through this thesis at the chair group Technology and Agrarian Development (TAD), for which I went to Tamil Nadu, southern India, to conduct a combined technical and sociological research on rice. Afterwards I can say that I have learned a great deal from this thesis, although it was not without facing any barriers or obstacles. My initial expectations about the mentioned personal interests and about this thesis were partly mistaken and have been adjusted by the experiences during the four months in Tamil Nadu. Altogether it was an interesting and educational experience, which gave me new insights and enriched me on scientific as well as on personal field.

Great thanks go to who made this thesis possible. First of all I want to thank my colleague and friend K. Senthilkumar for his inexhaustible efforts in arranging all the practical matters, for his translation activities, for his advice and ideas, for his company and most of all for his precious time. Without him, this thesis wouldn't have been possible. Great thanks also go to T.M. Thiyagarajan, Dean of the Agricultural College & Research Institute Killikulam, for his hospitality, for his efforts in arrange a place of residence, for the many concerns about my welfare, and for his frankness. Thanks goes to H. Maat, Technology and Agrarian Development, Wageningen University, supervisor of this thesis, for providing me with the subject for this thesis, for his expertise and advice, and for his patience with deliverance of this thesis. Thanks also goes to W.A. Stoop, researcher and expert on the field of SRI, who gave me useful advice during the onset of this thesis.

Furthermore I would like to thank G. Shanmuga Sundara Pandian, Junior Research Fellow within the PhD project of K. Senthilkumar, for some of his additional help; and N. de Ridder, Plant Production Systems, Wageningen University, for arranging several practical things in the onset of this thesis.

Edwin van der Maden

Wageningen, February 2006

Summary

Agriculture remains to be of great importance to the state of Tamil Nadu, India. Although with a minor share in the NSDP (Net State Domestic Product), agriculture still provides employment and livelihood to more than half of the population, supplies raw materials to industries, and is still needed for the state's food self-sufficiency and security. Therefore, a stable, secure and developing agricultural sector is essential for the state's future self-sufficiency and security of food and poverty alleviation, for Tamil Nadu's future development in general. However, at present the agricultural sector is under pressure in the view of current problems and future demands.

Water seems to become more and more a scarce resource in Tamil Nadu. Limited and irregular availability of water for irrigation is limiting crop production, especially in the case of the highly water demanding conventional rice cultivation. Furthermore, the intensification principles of the Green Revolution have reached their limits. In the future, with an increasing population, the present stagnation in the agricultural sector could lead to food shortage problems and increasing rural poverty. Therefore Government and scientists are in search for proper solutions to ensure the state's future agricultural development. A newly introduced rice cultivation technique, the System of Rice Intensification (SRI), which contains a water-saving practice, possibly provides a new option.

Nevertheless, the focus should not be too much on new technologies solely in solving the present problems in the agricultural sector of Tamil Nadu. It should be borne in mind that technology and the problems it tries to solve are socially constructed. The problem often is much more complicated and embedded in the social environment than it would seem on first sight. Therefore, with solving the present problems in the agricultural sector of Tamil Nadu with the introduction of new technologies, an attempt should be made to thoroughly understand the social environment in which these problems are occurring and in which the new technologies are being introduced. Therefore it is emphasized that with interdisciplinary and participatory research methods, inadequacy between theory and practice of technologies can be overcome, difficulties or incompetence at the implementation phase can be anticipated or prevented, and the need for implementing a new technology at all can be detected. With this thesis an attempt is made to describe, analyse and understand the present situation of the socio-technical rice cultivation environment in Tamil Nadu.

Farm surveys were conducted in the Tambiraparani river basin (Tirunelveli and Tuticorin Districts, Tamil Nadu). Additionally interviews with government officials and literature research were performed. The data gathered were subjected to a thorough

analysis, based on the social-technical technography approach. The situation and environment of the Tamil Nadu farmers, the problem of limited and irregular availability of water for crop irrigation, and the System of Rice Intensification as a possible solution to the present problems were the main focus of this thesis.

A mechanism explaining the farmers' motives for certain behaviour and actions was formulated, namely: 'risk aversion'. It seems that 'risk' is embedded in many aspects of the rice cultivation in Tamil Nadu, and that 'risk aversion' plays a major role in the farmers' decision making process.

Furthermore it was concluded that participation between government and farmers is indispensable for resolving the present problems in the agricultural sector, and that fine tuning of the mutual communication between Governmental departments is of importance for efficient, effective and successful development and implementation of policies. At the moment this is lacking.

It seems that the System of Rice Intensification, although it proves to be a promising option, is just one of the many alterations that have to be accomplished within the rice cultivation environment of Tamil Nadu to solve the present problems. Additionally, the SRI could only be of significant importance in solving the present water problem in Tamil Nadu with the widespread adoption among the farmer society. Successful and widespread implementation will depend upon a complete change of the whole social-technical environment, comprehending all elements, actors and factors concerned; i.e. the introduction of a new technology (such as the SRI) in a social-technical environment (such as Tamil Nadu) will provoke imbalance, and thus a new socio-technical equilibrium has to be established before problems can be successfully solved.

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1 Introduction

1.1 Background of the research

The initial idea for this research was born in July 2004 during the search for a suitable thesis subject at the chair group Technology and Agrarian Development (TAD), Wageningen University. Harro Maat attracted my attention with the providence of the first information on the System of Rice Intensification (SRI), a concept unknown to me before that time. Reading more on this subject got me more and more interested, because of the divergent principles of the SRI, it's promising implementation possibilities and the possibility for a multi disciplinary research, between technological and social aspects in line with research of the TAD chair group.

The initial idea was born, but a location for conducting the research was not yet found. Until accidentally I got in contact with K. Senthilkumar, a PhD student at Wageningen University, who was preparing his PhD project 'Design of integrated rice-based farming systems for resource poor farmers to enhance farm productivity' in the Netherlands and which was going to take place in Tamil Nadu. For his MSc thesis he conducted two experiments on SRI in Tamil Nadu, under the supervision of Dr. T. M. Thiyagarajan, at the Tamil Nadu Agricultural University. The SRI was just introduced in Tamil Nadu and the first experiments and farm trials were conducted. Furthermore, with a research on SRI in Tamil Nadu an extra dimension could be given to my thesis research, as there were problems with the availability of water for crop irrigation in the area and SRI was a promising possible solution to this problem. After K. Senthilkumar gave me the opportunity to do my research in collaboration with his PhD project, all the arrangements could be made and the thesis subject and location were a fact.

1.2 Introduction to Tamil Nadu

Tamil Nadu is the most Southern state of India, located between 8º5'-13º35'N and 76º15'-80º20'E. Although Tamil Nadu is undergoing fast developments regarding the industrial and service sectors and is one of the most industrialized states of India, the agricultural sector is still of great importance to Tamil Nadu. More than 65% of the population depends on the agricultural sector for a living (Government of Tamil Nadu, 2003). Agriculture provides employment and livelihood and is still needed for the state's food self-sufficiency and security. However, in the process of the state's development, the share of agriculture in the Net State Domestic Product (NSDP) has declined from about 53% in 1950/51 to 17% in 2001/02, due to higher productivity and production in the growing non-agricultural sectors; the share of the secondary and tertiary sectors has increased from 14% and 33%, respectively in 1950/51 to 34% and 49% in 2001/02 (Government of Tamil Nadu, 2003). This decline of the relative share of agriculture in the NSDP, can be ascribed to the lack of relative growth in agriculture. Nevertheless, in the process of diversification of the economy, one would also expect a shift in the share of workers from the primary sector to the secondary and tertiary sectors. But such a shift has not taken place, while about 50% of the working population continues to depend on agriculture for employment and income (Government of Tamil Nadu, 2003). Therefore a considerable difference exists between the average income of persons depending on the agricultural sector and depending on the secondary or tertiary sector, with the result of increasing differences in income between the rural and urban populations.

Tamil Nadu has a total area of about 130,000 square kilometres, of which in 2003/04 36% was cultivated, 16% was used for non-agricultural purpose and 22% was fallow land (26% is classified in minor categories). Of the in 2003/2004 cultivated area 46% was irrigated and 26% was cultivated with rice (in general always irrigated), with an average productivity of 2308 kg/ha. Rice is the state's staple food for about 65% of the population. In the period of the 1950s to the 1990s the averages of the cultivated area increased from 43% in the 1950s to 47% in 1970s and subsequently decreased again to 43% in the 1990s. In the same period the area used for non-agricultural use increased from 10% to 15% and fallow land increased from 14% to 17%. The area irrigated, as part of the cultivated area, increased from 37% to 49% and the area cultivated with rice increased from 31% in the 1950s to 35% in the 1970s and subsequently decreased again to 32% in the 1990s. The trend of the last three years (2001/02 – 2003/04) is showing a decline in total cultivated area, irrigated area, area cultivated with rice and productivity of rice (appendix A table A.1, A.2 and A.3; Department of Economics, 2004; State Planning Commission, 2004). The above figures show that the agricultural sector is stagnating, although growth and development is required. The major economic growth of the state is due to the industrial and service sectors, however it is the agricultural sector that has to provide food for the people in all sectors.

The human population of Tamil Nadu in 2001 numbered 62.4 million, opposed to 55.9 million in 1991, with a decennial (1991-2001) growth rate of 11,72% and a population density of 480 persons per square kilometre compared to a population density of 429 in 1991 (Census 2001; Census 1991; Government of Tamil Nadu, 2003). 56% of the population lives in rural areas and 35% of the population is illiterate; 67% of the illiterates live in rural areas, which is 42% of the total rural population (Census 2001; Department of Economics, 2004). Although the (rural) population dependent on agriculture has increased during the last decades, the absolute contribution of agriculture to the NSDP, at constant prices, has remained nearly constant. As a result rural poverty has increased (State Planning Commission, 2004). The rate of the state's population growth is declining, but the absolute number of people continues to increase. It is estimated that with an average annual growth rate of 1.3% and 1.1% between 2001-2010 and 2010-2020 respectively, population will reach up to a number of 70.1 million in 2010 and 78.2 million in 2020 (State Planning Commission, 2004). With a percentage of 88% of the total population, Hinduism is the main religion being followed in Tamil Nadu. Other major religions are Christianity (6%) and Islam (5%) (Census 2001; Department of Economics, 2004).

Although the actual rice cultivation is in the hands of the farmers, the government indirectly has strong involvements in various components of the rice farming activities. India has a parliamentary democracy, nominally headed by the President though real power is in the hands of the Prime Minister. There is strict division between activities handled by the states and those handled by the national Government. The police force, education, agriculture and industry are reserved for the state Government. Other areas are jointly administrated by both levels of Government. The federal Government has the controversial right to assume power in any state if the situation in that state is deemed to be unmanageable, known as the President's Rule (Plunkett *et al.*, 2001).

At state level, the Chief Minister is responsible to the legislature in the same way as the Prime Minister is responsible to parliament. Next to this, each state has a Governor, who is appointed by the President and who may assume wide powers in times of crisis (Plunkett *et al.*, 2001). The Government of Tamil Nadu consists of 35 different departments, with each its own minister and secretary. Every department has several sub-departments and divisions below them. Furthermore, every state's district has a Collector, who is the highest civil authority within a district. The District Collector functions as the supervisor and overseer of the district Government machinery. He is the first representative of the state Government who looks after several functions directly and coordinates the functioning of many other departments which do not directly work under him. The District Collector has the authority to look into any matter of governance in the district and is the overseer and coordinator for all acts of governance, though he himself or his office may not be directly responsible for the implementation of many of these activities.

The governmental system in Tamil Nadu (and in the rest of India) is a complex system of Government officials and employees, departments, sub departments and divisions, with each of them again its own structure of organisation. It is hard to fathom the organisation and functioning of the total governmental system, but it is clear that it has a formal, top-down pyramid like vertical structure of organisation. Such an organisation structure can work very efficient and effective, if all bodies, officials and employees are functioning as they are supposed to. On the other hand, the transparency is low, the length of communication lines is long, and the sensitivity for stagnations and corruption is high. In India deficient organisation and past corruption has had its influence on the function of the Government. At present the improvement of the organisation structure and the struggle against corruption are continuing (appendix G, article 9), and the after-effect of the past imperfections are still visible. This is displayed nowadays by the to a certain extent bureaucratic, stiff, and inefficient machinery of Government.

For the agricultural sector and farmers in particular, most important and direct involved (according to farmers, farm surveys) are several sub-departments of the Department of Agriculture and the Public Works Department. Within the Department of Agriculture these are the Directorate of Agriculture (extension) and Agricultural Engineering (irrigation structures at farm/field level). Within the Public Works Department it is the Water Resources Organisation (irrigation infrastructure, water regulation and distribution).

The only Agricultural University in Tamil Nadu, the Tamil Nadu Agricultural University (TNAU), is part of the Department of Agriculture. Several Government officials from the Department of Agriculture are a member of the Board of Management, the administrative body, and of several councils of the university, with the Vice-Chancellor as its chairman. The university works especially close with the Directorate of Agriculture (extension), as this is the body that is involved in the deliverance of new technologies researched by the university to the farmers.

Agriculture still remains of great importance to Tamil Nadu as it provides employment and livelihood to the majority of the population, needs to feed the greater part of the population and supplies raw materials to industries. Therefore, in this view a stable, secure and developing agricultural sector is essential for Tamil Nadu’s future development. But at the moment the agricultural sector of Tamil Nadu is facing a problem of limited and irregular availability of water for crop irrigation, which mainly causes problems for the cultivation of conventional rice. Increasing rice productivity seems to be one of the things that has to be realised to meet the future demands. Accordingly, a more efficient use of water in the agriculture sector seems to play a major role in this. However, the problem of limited and irregular availability of water for crop irrigation is not limited to the technical field, but also includes a larger area covering different levels of society. In the following sections this will be further illustrated.

1.3 Features of the study area

The research has been conducted in the Tambiraparani river basin, located in the Tirunelveli and Tuticorin districts in the south of Tamil Nadu. It is one of the important rice growing regions of the Tamil Nadu state. This location was chosen because the opportunity was given to conduct this research in collaboration with the first phase of K. Senthilkumar's PhD-project "Design of integrated rice-based farming systems for resource poor farmers to enhance farm productivity" (PhD, Wageningen UR) in the Tambiraparani river basin. Residence and facilities were provided by the Agricultural College & Research Institute Killikulam (TNAU), the home base for K. Senthilkumar's PhD research and located in the area. Furthermore, there had already been contact between several farmers in this area and the AC & RI Killikulam for the 2003 State Plan Scheme on SRI, which created an ideal environment and initial group of farmers as a starting point for this research.

Tirunelveli

The Tirunelveli district is the penultimate southern most district of Tamil Nadu. The name Tirunelveli is composed of three Tamil words, i.e. 'Thiru-Nel-Veli', which means 'sacred paddy hedge'. The district does not belie its name, as rice is the main agricultural crop in the area. The Tirunelveli district has a total area of 6,823 square kilometres, of which 20% is cultivated. Of the cultivated area 64% is irrigated and 35% is cultivated with rice, which is in general always irrigated (Department of Economics, 2004). The district has a population of 2.80 million, with a population density of 410 persons per square kilometre, of which 54% is rural (Census 2001; Indian overseas bank – Tirunelveli, 2004).

Tuticorin

The Tuticorin district is situated in the extreme south-eastern corner of Tamil Nadu state. It has a total area of 4,621 square kilometres, of which 34% is cultivated. Only a small part in the south of the district is covered by the Tambiraparani river basin's command area. Of the cultivated area 23% is irrigated and 8% is cultivated with rice, which is in general always irrigated (Department of Economics, 2004). The district has a population of 1.57 million, with a population density of 338 persons per square kilometre, of which 58% is rural (Census 2001; State bank of India – Tuticorin, 2004).

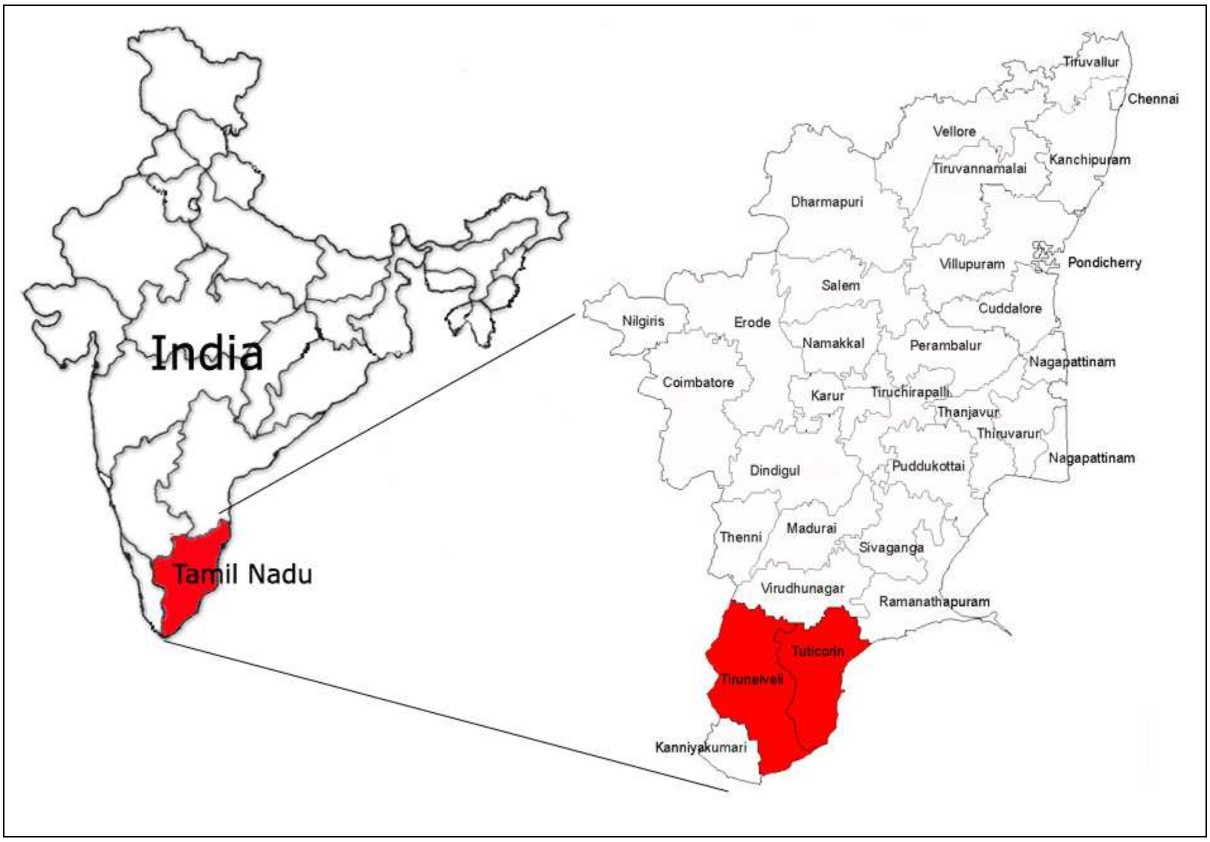

Figure 1.1: Location of Tirunelveli and Tuticorin districts

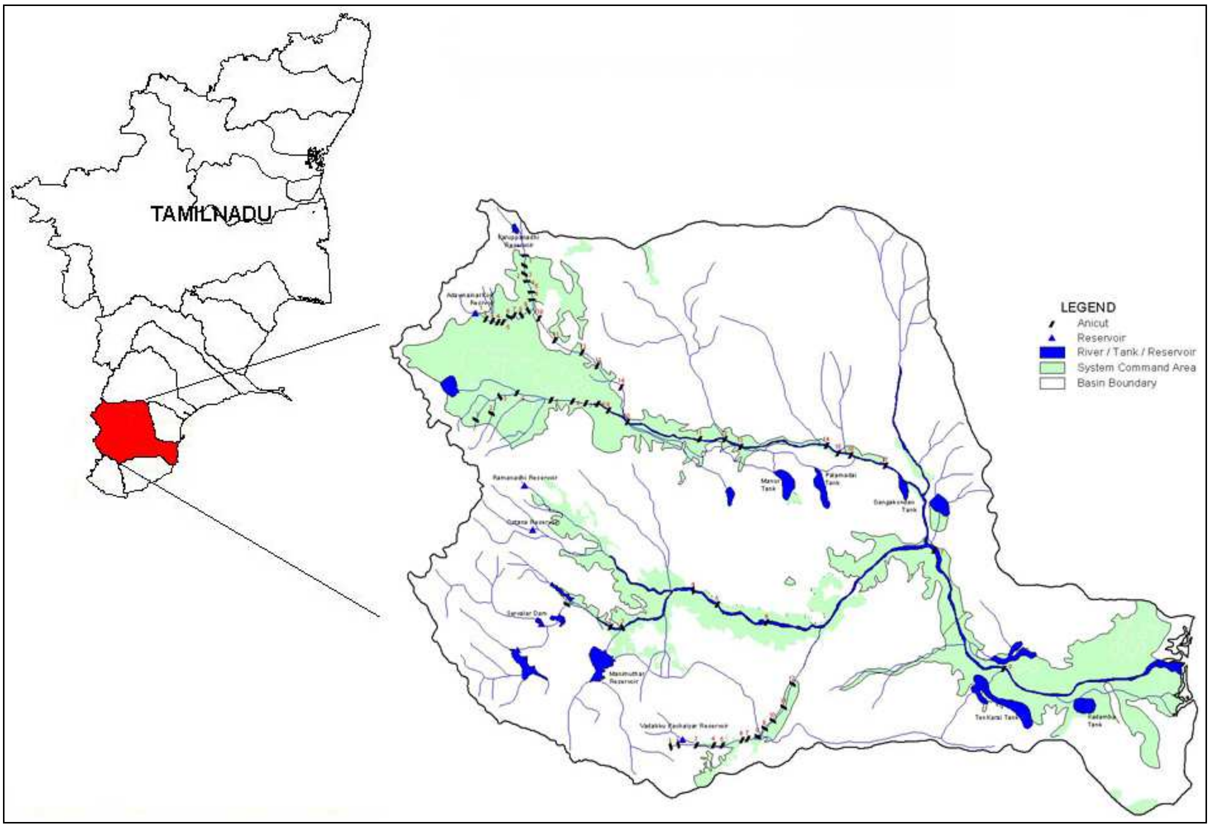

Figure 1.2: Location and layout of the Tambiraparani river basin

1.3.1 Rainfall

The rainfall in the districts is very unpredictable, erratic and is unequal distributed during the year. Showers occur mainly in two distinct seasons, namely, south-west monsoon (June to September) and north-east monsoon (October to December). The remaining seasons are the winter season (January to February) and the hot summer season (March to May). The water resources in the districts are fully dependent on the monsoon rainfalls. A substantial part of 60% of the mean annual rainfall of 752 mm in the command area of the Tambiraparani river basin is taken on by the north-east monsoon (Brewer *et al.*, 1997; Indian overseas bank – Tirunelveli, 2004). A major part of the monsoon rainfalls is also received by the catchment area of the Tambiraparani river basin in the Western Ghat mountains.

The seasonality and occurrence of the north-east monsoon rainfall determines to a large extent the timing and possibility for growing rice in the districts. While the rain falls down in short periods, water harvest is of importance to secure crop irrigation during the rice growing seasons. Normally rice can be grown one or two times a year depending on farmers' location, irrigation facilities and monsoon occurrence. In appendix A Table A.5 the seasonal rainfall data of Tamil Nadu from 1970 to 1999 are being displayed.

1.3.2 System irrigation: The Tambiraparani river basin

The river Tambiraparani serves one of the oldest irrigation systems in Tamil Nadu. It originates from the Pothigai hills in the Western Ghat mountains and flows south-eastwards over 120 kilometres through the Tirunelveli and Tuticorin districts, with several tributaries joining the river, to the Gulf of Mannar in the Bay of Bengal. The bigger tributaries of the river are Servalar, Manimuthar, Gadana, Pachaiyar and Chittar. The system consists of three main reservoirs, eight anicuts (diversion weirs), eleven channels and includes 187 system tanks (small reservoirs). It is the life-line of both Tiruneveli and Tuticorin districts for agriculture, industry and domestic water use. The total command area of the Tambiraparani river basin is 34,934 hectares (Brewer *et al.*, 1997).

The realisation of the Tambiraparani system dates back several centuries. At the time tanks were constructed in various parts of the present command area of the Tambiraparani system by villagers for crop irrigation. Preliminarily to the British colonialism, seven anicuts and nine channels were constructed to lead the water to the existing local tanks and for direct irrigation of the fields from several channels. An eighth anicut and two more channels were constructed during the time of British colonialism (Brewer *et al.*, 1997).

In 1944 the Papanasam reservoir, also called Hope reservoir or Tambiraparani reservoir, located in the Ambasamudram taluk, was constructed by the Government for catchment, flood control and hydroelectric power generation. In 1985 the Tamil Nadu Public Works Department constructed the Manimuthar reservoir across the Manimuthar river, the first tributary of the river Tambiraparani, for stabilizing the irrigation area of the Tambiraparani sytem and to divide surplus water to 349 tanks around the system area. The last reservoir, the Servalar reservoir, was constructed in 1986 by the Tamil Nadu Electricity Board across the Servalar river, another tributary of the river Tambiraparani. The Servalar reservoir is linked to the Papanasam reservoir by a tunnel and a powerhouse at the foot of the dam was constructed for hydroelectric power generation (Brewer *et al.*, 1997).

The Tambiraparani catchment area receives more than 4,000 millimetres of rainfall annually, mainly from both the south-west monsoon (June-September) and the north-east monsoon (October-December) (Brewer *et al.*, 1997). Rains of both monsoons will also fall in the command area, but are much lighter compared to the catchment area, especially the south-west monsoon. Most of the water is captured in the three main reservoirs or in reservoirs on other tributaries of the river Tambiraparani. Farmers irrigate directly from the channels or indirectly from the 187 system tanks fed by the channel (Brewer *et al.*, 1997). In appendix B a flow diagram and a table of the components of the Tambiraparani system are displayed.

Since the completion of the Papanasam reservoir in the 1940s, several changes have occurred in the use of water in the Tambiraparani system (Brewer *et al.*, 1997). First of all, the original purpose of the system was to provide irrigation water for the agricultural sector in the command area, but gradually other purposes and sectors also came into the picture, i.e. power generation, industry and municipal supply: water for power generation is now used throughout the year; because of industrial development (especially around Tuticorin city) the number of major industrial plants (including a thermal power station) grew from 1 in the 1950s to 7 at present and also smaller industrial water users are now located within the system; water for domestic use had always taken place within the system, but from the 1950s until present the water use grew from 1 (Tuticorin city) to 48 municipal water supply schemes drawing water from the system. Secondly, the area irrigated increased: although the official command area of the Tambiraparani river basin is 34,934 hectares, it is estimated that the actual irrigated area ranges between 38,000 and 41,000 hectares. Furthermore, the cropping pattern changed and banana became, next to rice, a major crop: the cropping season changed from growing rice in the whole command area during pishanam and kar season (with system closure and no water release for agricultural use in April – May, for system repairs) to the in 1969 introduction of the advanced kar season for the tail end of the system, and still again the cropping season is changing (section 1.3.3); especially in the tail end of the system bananas have become a major crop, with the problem that this crop grows year-round without seasonal planting and harvesting and thus needs year-round irrigation.

Because of the (continuing) changes in water use in the Tambiraparani system, the original water distribution rules for the system do not longer match with the changed water uses, and discrepancies have occurred. During the last decades no major amendments were made to the rules of regulation of the system. The existence of deficiencies in the distribution rules of Tambiraparani system is confirmed by a case study of Brewer *et al.* (1997) on the water distribution rules and water distribution performance of the Tambiraparani irrigation system. Brewer *et al.* argue that:

> "if the water distribution rules define a pattern of water delivery that does not match technically feasible goals of water users, then the users will subvert the rules. This will lead to poor water delivery performance […] Inconsistency in the water distribution rules creates difficulties in system operations that are likely to lead to inefficient and inequitable water distribution performance […] Increasing demands on irrigation systems from both farmers and other users make it essential to modify water distribution rules over time […] Involvement of the users in these changes is essential to ensure that the distribution rules serve their desires and that the users accept the limitations on uses imposed by water availability and the features of the system" (Brewer *et al.*, 1997)

It seems from Brewer *et al.*, that with formulation of renewed system distribution rules, with the involvement of users, several important discrepancies can be put aside, clearing the way for more efficient and equitable distribution of the system's water supply. However, what Brewer *et al.* do not tell is how such renewal can best be implemented.

The water management of fields within the Tambiraparani system is a difficult job. The date and time of water release from the reservoirs is decided by the Water Resource Organisation (WRO), are subjected to water distribution rules, and release date and time are announced only a short time before the actual release. Cultivation and irrigation choices and practices are subjected to the time and amount of water release. The amount of water inflow into the field is difficult to control, especially in lowlands, which will be submerged by excess water from highlands and where drainage is difficult. Furthermore, the above pointed out discrepancies between the water distribution rules and demands cause even more difficulties and limitations for the farmers.

1.3.3 Cropping pattern Tambiraparani river basin

The former / original irrigation and cropping plan for rice-based systems in the Tambiraparani Irrigation System in the Tirunelveli and Tuticorin districts, according to the cropping seasons in the districts, was set up as following:

1. <u>Advance Kar season (April – July)</u>
   Rice is being cultivated in the tail end area (at least the four last channels, Tuticorin district), to utilize the water released for power generation in the months April and May and the flows and run-off, if any, due to summer showers. The area under cultivation during advance kar is decided depending upon the availability of water in the reservoir and tanks on 1st April. After the harvest of advance kar, in the tail end area pulses are being cultivated using the residual moisture in the soil
2. <u>Kar season (June – September)</u>
   All area is eligible for rice cultivation during kar, except the areas permitted for cultivation during advance kar (channels tail end area).
   Water is released to the channels from 1st June, if water stored in the reservoirs is sufficient. Otherwise channels will be opened, from head to tail, depending on water availability in the reservoirs.
3. <u>Pishanam season (October – January)</u>
   Generally there will be no water scarcity in this season. The North-East monsoon rainfalls will supply adequately water amounts and sufficient water will be stored in the reservoirs. Generally, water is released to all eleven channels on 1st of October for irrigation and cultivation of rice. After the harvest of pishanam, in the head reach and middle reach areas, pulses are being cultivated using the residual moisture in the soil.

Due to erratic monsoon rainfalls during the last years, which decreased the water storage in the catchment areas, and growing demands for water, the irrigation and cropping plan was forced to be changed. Insufficient water storage for irrigation during the complete advance kar season for rice cultivation made the Water Resource Organisation decide to completely cancel the water release to the Tuticorin district during this season. This is done to protect farmers from the mistake of starting a rice crop when water in the beginning of the season seems available, but which is insufficient for completing the crop. This looks a fair decision because it means that farmers are protected against a crop failure in this way. It however is a radical decision. By cutting off the water there will certainly be no crop while for subsistence farmers even a small amount of water in combination with a different crop than rice may be preferred over no harvest at all. The farmers in this area depending on the Tambiraparani system for the irrigation of their crops are now forced to leave their land fallow during this period and are only able to grow one rice crop a year. During a year the farmers in the Tirunelvelli district will have 10 months (Jun – Mar) of water from the Tambiraparani system at their disposal, in contrary to the farmers in the Tuticorin district, who will have the availability over only 6 months (Oct – Mar) of water from the system.

Table 1.1: Former and present cropping pattern for rice-based cultivation systems in the Tambiraparani Irrigation System

District	Former Situation			Present Situation		
	Season	Months*	Crop	Season	Months*	Crop
Tirunelveli	1st Kar	Jun – Sep	Rice	1st Kar	Jun – Sep	Rice
	2nd Pishanam	Oct – Jan	Rice	2nd Pishanam	Oct – Jan	Rice
	3rd Summer	Feb – Apr	Pulse	3rd Summer	Feb – Apr	Pulse
Tuticorin	1st Advance Kar	Apr – Jul	Rice	1st Advance Kar	Apr – Jul	-
	2nd Adipattam	Jun – Aug	Pulse	2nd Pishanam	Oct – Jan	Rice
	3rd Pishanam	Oct – Jan	Rice	3rd Summer	Feb – Apr	Pulse

*) The start of the season may vary

1.3.4 Well irrigation

Compared to the Tambiraparani system, water management in well-irrigated fields is a much more straightforward activity. If water is available in the well, the time and amount of irrigation can be fully controlled, which makes it possible to properly plan cultivation and irrigation practices. Therefore, farmers can choose from a large range of crops to cultivate.

Farms located within the Tambiraparani system with next to canal / system tank irrigation also a well at their disposal, will use the well as an additional source for crop irrigation when surface water supplies are not sufficient during the cropping season, particularly during April and May when no water is released from the Tambiraparani system, or for more control over the irrigation activity. Farms with separate canal / system tank and (high land) well-irrigated areas mainly crop vegetables or cash crops in these fields. The farms not located within the command area of the Tambiraparani system, are relying on a well as the main source for crop irrigation, with mostly a rain fed tank as an additional source. Some farms are having a rain fed area as well on which they will grow mainly low water demanding crops like pulses.

The water availability in the wells is accessible throughout the year, but will currently only be sufficient for water demanding crops during and some period after the north-east monsoon period; during the monsoon months the groundwater level is going up and the wells also function as a water catchment basin. The water supply from the rain fed tanks will also only be available during and some months after the north-east monsoon.

Because of water scarcity and growing demand for water during the last years, the use of groundwater for irrigation is increasing and a lot of new wells are constructed.

Especially in the tail reach of the Tambiraparani system, farmers started to use more groundwater for irrigation, as in this area at present only 6 months of water from the system is available. This increasing use of groundwater for irrigations has led to a present overexploitation and declining of the groundwater level (see also section 1.4.3). Currently about 60% of the total irrigated area in Tamil Nadu is well-irrigated (appendix A table A.3).

1.3.5 Cropping pattern well areas

In the well areas, farmers have more freedom in deciding which crops to cultivate, because they are not restricted to the water distribution rules and release date and time set by the Water Resource Organisation. Nevertheless, they may have to face the problem of insufficient water availability in the well during certain periods of the cropping season, jointly caused by overexploitation of the groundwater level. During the Pishanam season they are more or less forced to crop rice, because the intensive monsoon rainfalls may cause water damage to other crops that cannot deal with these intensive amounts of water, even if drainage is possible. After the monsoon rainfalls the farmers are dependent on the water availability in their well to complete the rice crop, so in general only a small part of the total area is cropped with rice to evade the risk of water shortage at the end of the season. Moreover, most farmers will try to crop at least every year rice for food self-sufficiency. To gain farm income they will try to grow vegetables (e.g. tomato, bhendi, brinjal) and / or cash crops (e.g. cotton) during the remaining seasons, depending on the water availability in their well(s). Vegetables are high water-demanding crops, but because the irrigation can be fully controlled the farmers will adjust the area under vegetables to the available water in their well(s). A cash crop like cotton is a low water-demanding crop and therefore a larger area can be cultivated. In practice the farmer will cultivate his area with both vegetables and cash crops and leaves part of it fallow.

Table 1.2: Cropping pattern in areas with well as main irrigation source

Season		Months*	Crop
1^{st}	Adipattam	Jun – Sep	Vegetable / Cash crop
2^{nd}	Pishanam	Oct – Jan	Rice
3^{rd}	Summer	Feb – Apr	Vegetable / Cash crop

*) The start of the season may vary

1.4 Description and statement of the problem

1.4.1 Introduction

Since several years in Tamil Nadu a problem of limited and irregular availability of water for crop irrigation is limiting the potential production of crop cultivation, in particular in the case of the (highly water demanding) conventional rice cultivation. With a still further increasing population, a majority of the population being dependent on rice cultivation for employment and livelihood, a declining area under rice, declining rice productivity and rice being the state's staple food, increasing the rice productivity and water use efficiency have become a growing concern of Government and scientists for the state's future development of the agricultural sector and the Tamil Nadu's future self-sufficiency and security of food and poverty alleviation (appendix G, article 1).

Regarding the problem, the focus of research for finding solutions until now has mainly been on the level of the rice crop and the crop production system of the conventional rice cultivation. Yet, the introduction of the System of Rice Intensification (SRI), a new unconventional cultivation technique that contains a water-saving element, firstly taken cognisance of in 2000 and introduced in Tamil Nadu by Dr. T.M. Thiyagarajan, is gaining Tamil Nadu researchers' interest and creates new options. But nevertheless the problem of limited and irregular availability of water for crop irrigation is a complex problem, embedded in a broad and differentiated environment and taking place at different levels of society. Therefore solutions should not merely be found in the field of technology, but the socio-technical environment has to be taken into account as well. The implementation of outcomes of research done merely on one specific element and level (i.e. technical crop production system) and without taking into account the interrelated elements and levels of the whole socio-technical environment, can cause difficulties or full incompetence at the implementation phase.

All different kinds of actors, elements and stakeholders at different (integration) levels, e.g. technological, economical, sociological and political elements, are involved at levels ranging from plant and field to the state level. Within this complex environment farmers are important actors, as not the most important ones, as they are at the basis of solutions; i.e. the implementation of possible promising new technologies and policies. In that respect the SRI is an imperative example as it was developed in close interaction with farmer practice. In general technologies should be developed or adjusted to farmers' (social) situation and environment to make adoption successful. No technology stands alone; social dimensions have to be specified as well (Richards, 2004a) and dependence on purely quantitative methods may neglect the social and cultural construction of the variables which quantitative research seeks to correlate (Silverman, 2001).

Scientists working on solutions should try to understand and include farmers' situation, thinking and actions in the process of finding solutions; it should be understood how these farmers 'work' within the local conditions to make the introduction of new technologies possible and successful. To illustrate the importance of taking into consideration the behaviour / situation of the implementers of new technologies, there are several classic examples known of failed technologies in the agricultural history of colonialism, due to underestimating the role of farmers, that can confirm this (several examples in Richards, 1985). Therefore, with developing and introducing new technologies an attempt should be made to unravel and understand the complex environment in which the farmers are functioning and what their motives are for certain behaviour and actions. Use also should be made of the existing knowledge of farmers about the local conditions, if available. In this way inadequacy between theory and practice of technologies can be overcome.

Furthermore, one should not look at the single problem solely in trying to find ways to solve it. An attempt should be made to discover what is at the actual basis of the problem, to look beyond the perceived problem with a view from a broader perspective. Merely developing technologies with a short-sighted view on case specific problems (in this case, more water efficient rice production systems) will mostly only solve part of the actual larger problem or are just temporarily solutions.

For this thesis, a research has been carried out with a broader view on the rice cultivation in Tamil Nadu, including factors at different levels of the socio-technical environment. This is done to get a first and more profound understanding about the problems that are occurring; to give a first onset to a more interdisciplinary, participating, broader way of research for the development of new technologies to solve the present problems in the agricultural sector of Tamil Nadu; and to predict the success of the possibilities brought up with the introduction of the SRI as a viable solution. The main focus of this research are the rice farmers, the problem of limited and irregular availability of water for crop irrigation and the newly introduced SRI. These three actors / factors are specified and briefly discussed in more detail below.

1.4.2 Farmers

After independency of India in 1947, the era of the British colonialism left behind a controversial tenure system, which was introduced to strengthen British India revenues. The British system comprehended the commission of landlords (Jagirdars, Zamindars), with the task of collecting land rent from tenants and to pass on a certain agreed percentage of it to the Government treasury. Principally they functioned as intermediary between the tenants and the Government, but were given also additional privileges, i.e. the right to extract land rent from the tenants to any feasible extent. The tenants on the other had merely duties to the landlord and no privileges, while the landlord had no duties at all towards the tenants (Shariff, 1987). After independency this system continued to exist.

As a result the structure of landholding was characterized by heavy concentration of cultivable areas in the hands of relatively large landowners, excessive fragmentation of small landholdings and a growing class of landless agricultural workers (Heitzman & Worden, 1996). Since a few years after the independence in 1947, the Central Government of India has been putting efforts in bring about a unified land policy. With a programme of land reforms across the different states, the Government has intended to ensure a more uniform distribution of income from the point of social justice and to remove barriers to agricultural and economic development. With the formulation of the land policy in the First Five-Year Plan in 1950, the Central Government intended to remove the obstacles and defects to development of the agricultural sector, and to eliminate all forms of exploitation and injustice within the agrarian structure (Shariff, 1987). Therefore the following fourfold programme was formulated: 1) Abolition of intermediaries (landlords); 2) Tenancy reforms (e.g. measures of fixing rents); 3) Ceilings on land holdings (and distribution of surplus lands to landless agricultural workers) and 4) Consolidation of land holdings (reallocation of land) (Shariff, 1987; Heitzman & Worden, 1996).

Unfortunately, it has to be concluded that the promising land reforms have failed to reach their aims. This is displayed by the present large number of marginal and small farmers. Of the total number of 8.2 million farm holdings in Tamil Nadu 89% are marginal and small holdings (< 2 ha) with a share of 52% in the total operated area, and the numbers are increasing every year (appendix A table A.4). Furthermore, a lot of surplus lands still have to be redistributed and the number of landless agricultural workers is still high. Although, the land reforms are not a complete failure while they have had beneficial consequences, but they did not succeed in their central intended purpose (Shariff, 1987). Different reasons for failure can be accounted for this. There was now centralized authority for the implementation of the land reforms, i.e. every individual state could decide upon the way of implementation. This brought about a variation in implementation intensity and conceptualisation of regulation (resistance, high costs and poor administration delayed the process substantial, which created the opportunity for large landholders to use methods of evading the ceilings). In general there was an inexcusable slow implementation phase and a lack of effective and adequate actual implementation (Shariff, 1987). At present the Government of Tamil Nadu is still engaged with the land reform problems, for which several Government sub departments are appointed, and yet there is a long way to go to reach the original land reform aims.

Tradition and unwillingness of farmers to participate is an obstacle as well. In case of consolidation of land, it can be very difficult to persuade a farmer to exchange a plot of land which he has been cultivating for years and which has been in the family for generations, for a parcel of someone else's land which lies adjacent to his own (State Planning Commission, 2004). Furthermore, for an original family landholding the tendency existed to gradually subdivide the land from one generation to the next (at present such a tendency still exists, but to a smaller extent). This resulted in a situation of many landholdings too small to provide a livelihood for a family. Therefore borrowing money against land was a frequently phenomenon, which resulted in the loss of land to a moneylender or large landholder, further widening the gap between large landholders, small landholders and landless agricultural workers (Heitzman & Worden, 1996).

The present large and increasing number of small farmers creates an unfavourable situation for development and modernisation in the agricultural sector, and the fragmentation of land results in what from modernization perspective seems an uneconomic land holdings (State Planning Commission Tamil Nadu, 2004). Especially the marginal and small farmers are dependent on rice cultivation for food, income and labour possibilities to secure their livelihood. And they survive, which is not to say that improvements are unnecessary. Therefore the present problematic limited and irregular water availability situation increases the risk for an unstable and declining livelihood for these farmers and their families.

The Tamil Nadu farmers are the first in row who are directly facing the problem of limited and irregular availability of water for crop irrigation, which is defined by them as the major limiting and uncontrollable crop production factor (farm surveys, section 4.3). This production factor largely masters their other cultivation decisions and practices. On the basis of the forecast of available irrigation water farmers decide which crop to cultivate or even if to cultivate at all. When enough water is available most farmers will at least try to grow rice once a year, for family consumption.

However, although most farmers are conscious of the state's present scarce water resources, the majority of the farmers are not engaged with the larger scaled problems of water in the state. They are more concerned with the everyday matter of ensuring livelihood for their families. A comparison can be made with Hardin's "The Tragedy of the Commons" (Hardin, 1968). In Hardin's article it is discussed that individuals do not use the "commons" (any resource which is shared by a group of people) in a fair equally shared way, but every individual is using it as much as possible to gain maximum profit from it, even with unfavourable consequences for others and eventually for themselves as well. In the end, when population grows and greed runs rampant, the commons collapses and ends in "the tragedy of the commons" (Hardin, 1968). A similar comparable situation is taking place in Tamil Nadu, for example in case of the canal irrigation where irrigation water is unequally divided between and used by head reach and tail end farmers or in case of depletion of the groundwater level.

Although, on the other hand the farmers are the ones that are at the basis of the solution; they will have to implement the technologies that result from research and policy building by scientists and Government. Therefore farmers are an important factor to take into consideration. But at the moment there is hardly any structured farmers' participation in the development of new technologies and farmers' awareness of future problems due to overexploitation of the scarce water resources is low. At present only a small part of the total number of farmers are in direct contact with researchers, universities or extension service officials, which are as well mainly the more educated and commercial farmers (farm surveys, section 4.3). Introduction of (completely) new rice cultivation techniques, in this case the SRI, and predicting the necessity, possibility and successfulness of this technology consists not only of the research for the technical implementation possibilities. Delivering a package of cultivation operations designed by science is not enough. Researchers and farmers should together come to the best ways of implementation of new technologies under the local social and environmental conditions. At least, with the introduction of a new technology, the social conditions of the (farmer) community in which it is introduced has to be taken into account, e.g. a traditional way of rice cultivation has to be adjusted, and farmers and researchers both have to be convinced of the success and advantages of the new cultivation techniques. Thus, a good understanding about farmers' situation, actions and behaviour plays a major role in resolving the current problems in Tamil Nadu's agricultural sector. A more participatory way of research, in multiple ways, could be a good way of combining the technical and social elements.

1.4.3 Water

The Tamil Nadu water resources are fully dependent on the monsoon rainfalls. The state receives rainfall mainly in two distinct seasons, namely, south-west monsoon (June to September) and north-east monsoon (October to December). The remaining seasons are the winter season (January to February) and the hot summer season (March to May). The rainfall is very unpredictable, erratic and is unequal distributed during the year (appendix A table A.5 for detailed rainfall data 1970 – 2000).

Agriculture is the single largest consumer of water in Tamil Nadu, consuming about 75% of the state's water resources (State Planning Commission, 2004). From the 1950s to the 1990s the irrigated area has increased, but the last three years (2001/02 – 2003/04) the figures show a strong decrease of the irrigated area (appendix A table A.3). At present water is a serious limiting crop production factor as the state almost reached the limit of using all the possible water potentials. The net area irrigated by surface water (canal and tank) has decreased during the last 50 years. Subsequently the ground water resources have been utilized for compensation and even for stabilization of the existing area under irrigation (appendix A table A.3). Furthermore, the rapid expansion of use of groundwater in the post Green Revolution era has contributed significantly to agricultural development, but with the result of overexploitation and drastically decline of the ground water table. Tamil Nadu is one of the parts of India, where overexploitation of the groundwater has resulted in a declining groundwater level, which is in the order of 1-2 m/year (Singh, 2002). It has been reported that in the last 40-50 years, the groundwater table in Tamil Nadu has depleted from 10 to 50 meters in several districts (Singh, 2002). At present about 50% of the total irrigated area is irrigated by groundwater. Furthermore, free or subsidized electricity for farmers creates the opportunity to pump the groundwater to the surface relatively cheap. With an almost full use of the water potentials in the state, there is hardly any recharging of the water sources. Furthermore, many water capture structures are old-fashioned and poor maintained, which results in a below potential use or unnecessary water losses (Appendix G, article 2, 3 & 4). Shortage in the state has already resulted in the reduction of the irrigated rice area and in a shift towards less water demanding crop activities.

With the increasing demands and stagnating supply for water, agriculture is competing with other stakeholders for the scarce water resources. For a country or state in the process of development, it is a common phenomenon that the industrial sector will expand. So it is the case in Tamil Nadu. With the expansion of the industrial sector the demand for water resources for industrial processes is also increasing. Furthermore, the increasing demand of the growing population for qualitative drinking water, is putting an additional burden on the potential water sources. If the present water usages are not restructured with alternative options, the situation will only aggravate as the water sources are under full constant pressure and no possibility exists for recharging them.

The present and possibly alarming future situation described above is merely based on the available numbers and figures. But what we actually have to ask ourselves is if the farmers are aware of these facts? And if they are, are they as anxious about it as presented above? Is their criterion of efficient water usage the same as that of a water engineer or researcher? In the search for and development of alternative technologies to face the water problem, this kind of questions should be borne in mind.

1.4.4 Rice and SRI

Rice remains to be the dominant food in Tamil Nadu. It is a component of almost every meal and is prepared and served in different forms. With an area of about one fourth of the total cultivated area, rice is the main crop to be cultivated in Tamil Nadu and it takes in more than half of the total irrigated area (Department of Economics, 2004). The recommended water management in conventional rice cultivation is irrigation up to 5 cm depth one day after disappearance of flooded water. However, the majority of the state's rice farmers are having difficulties with following this kind of water management practice due to limited, irregular and uncertain water availability. Other crop production factors seem to be less a problem to overcome (nutrients, pest & disease management, planting materials, etc.) (farm surveys, section 4.3). Under the present situation of difficulties with the irrigation management of the rice crop, reduction in yield, total crop failure, forced fallow fields and on a larger scale declining area under rice and a shift towards less water demanding crop activities are the result.

The during the 1970s and 1980s increasing demands for rice were met by the intensification principles of the Green Revolution (increasing external inputs, mechanization, chemical pest and weed control and high yielding varieties), which were mainly based on the intensively irrigated conventional rice system. With water as the present major limiting crop production factor for rice in Tamil Nadu and the current research on further intensification is reaching its limits, it is time for new options. Instead of looking for options in further intensification of the rice cultivation, a shift has to be made towards research on more efficient and alternative use of the available water; i.e. instead of a second Green Revolution, a 'Blue Revolution' is needed.

The introduction of the System of Rice Intensification (SRI) (also know as Transformed Rice Cultivation (TRC) in India or "Thirunthiya nel sagupadi" (in Tamil language) in Tamil Nadu by Dr. T.M. Thiyagarajan, creates a possible new option for ensuring future food self-sufficiency, food security and poverty alleviation. The SRI, originally developed in Madagascar by Fr. Henri de Laulanié, during the 1980s, implies practices that strongly differ from the conventional flooded rice production system. In particularly it includes a water-saving irrigation technique with even increase in yield, which makes the SRI of special interest to Tamil Nadu. Several experiments carried out until now in Tamil Nadu, aimed at different practices and elements of the SRI, have had some promising experimental results (Thiyagarajan and Selvaraju (2001); Thiyagarajan et al., 2002; Thiyagarajan et al., 2003; Thiyagarajan et al., 2005).

The newly introduced SRI is at first sight a promising option for coping with the present problems in the agricultural sector. But still not everything is clear about the SRI. At present the Tamil Nadu Agricultural University (TNAU) is doing research in Tamil Nadu on the technical aspects and optimisation of the SRI by field experiments and on farm experiments. But still more research has to be done to explore the opportunities, limitations and the potential suitability of this innovative technology. Furthermore, research from different disciplines has to be done. Especially with a (totally) new cultivation technique like the SRI, there should not only be a focus on the technical part, but also on the social environment in which such a innovation is going to be introduced.

Not only the technical but also the social opportunities and limitations should be defined. Questions on the potential of the SRI as a solution for the present problems in Tamil Nadu and the best ways for successful introduction and adoption on a large scale, are questions that still partly remain unanswered.

The System of Rice Intensification (SRI) originated in 1983 at a small agricultural school in Antsirabe, Madagascar by the efforts of Father Henri de Laulanié. Laulanié came to Madagascar in 1961 from France to work with and help Malagasy farmers to improve their rice production systems. He established the agricultural school in 1981. The SRI was almost discovered by accident when due to lack of time for growing 30 days old rice seedlings several seedlings had to be transplanted at an age of 15 days old. Furthermore, the school was already using a fairly wide spacing (25x25 cm) of single seedlings and were facing drought conditions in that year. Surprisingly Laulanié observed tremendous increase in tillering, rooting, the subsequent number of grains and yield. Following this, several other experiments were tried with young seedlings, which led to the same findings.

At first the exact reason for the increase in yield could not be explained in a scientific way, until Laulanié read the work of Moreau (1987), in which the so called Katayama's tillering model was explained. From the analysis of Katayama it seemed that rice plants only achieve their full tillering potential when transplanted before entering the fourth phyllochron of growth and when grown under favourable conditions. With this analysis a first initial rational scientific explanation could be given of what first seemed to be merely an empirical observation. In 1990 Laulanié established the Malagasy NGO Association Tefy Saina (meaning "To improve the mind"), which started introducing the SRI among Malagasy farmers. In 1994 the Cornell International Institute for Food, Agriculture and Development (CIIFAD) in Ithaca, NY, started cooperating with Tefy Saina in the introducing of SRI to farmers in Madagascar as a more permanent alternative to the 'shifting' slash-and-burn agriculture practiced. Therewith, Laulanié build upon the local agricultural knowledge available. Just before Laulanié deceased in 1995, he published an article on SRI in the journal Tropicultura (Laulanié, 1993a). After the initial work of de Laulanié and with promoting activities of Norman Uphoff, who was part of the CIIFAD team in Madagascar, several articles were published on the SRI, both supporting and opposing SRI (references[1]), and SRI was gradually taken cognisance of by, introduced in and further researched in rice producing countries all over the world.

In an English translated unpublished paper Laulanié explains the main principles of the System of Rice Intensification (Laulanié, 1993b). The SRI principles are as

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1) See http://ciifad.cornell.edu/sri/sripapers.html for a comprehensive list of articles, papers and publications

following formulated by Laulanié, added with facts and descriptions of the SRI from later works (Stoop et al.., 2002; Uphoff, 2002):

1. *Raising seedlings on seed-beds, under carefully managed circumstances*
   The soil of the nursery should be kept moist, instead of saturated (conventional system). When seedlings are removed from the nursery for transplanting, they keep more soil with their roots keeping the roots more intact.
2. *Early transplanting of 8 to 15 days old seedlings*
   Instead of transplanting seedlings of 3 to 4 weeks old (conventional system), seedlings of 8 to 15 days old are transplanted (appendix F, photo 7-11). The seedling has only just formed two small leaves and the root is still very simple, with the seed still attached. The time between uprooting and transplanting should be minimal (15-30 minutes) and seedling roots should be kept moist. The seedlings should be transplanted only 1-2 cm deep, with the roots in a horizontal position so that the root tips can easily resume their growth and are fully covered with mud.
   If the transplanting of the seedling is done very carefully, there is less stress to the seedling and the seedling recovers more quickly from the transplanting act than if the seedling would have been transplanted at a later stage in its development. This has a much larger tillering as a result.
3. *Transplanting of single seedlings at a wide spacing*
   Instead of transplanting the seedlings in clumps of 3-4 plants at high density (conventional system), single seedlings are transplanted at a wide spacing (25 x 25 cm - 50 x 50 cm). Intraspecific competition is reduced in this way. This has an improved root development as a result. Furthermore, less seed is needed per unit of area.
4. *Carefully controlled water management*
   Instead of keeping the rice field flooded throughout the growing season (conventional system), the field is kept moist but never flooded during the vegetative growth phase. The soil should be lightly irrigated, with intermittent application of water. The field is allowed to dry out for several days, to the point of surface cracking. During the reproductive phase, a thin layer of water (1-2 cm) is kept on the field.
   In this way aerobic conditions are created in the root zone by which a greater root development is realised and the roots stay better intact during the development of the rice plant. Less amount of water is needed, which is convenient in areas where water is scarce.
5. *Early and regular weeding*
   When rice is not grown under flooded conditions, weeds are likely to become a problem. So it is necessary to do several weedings. When the seedlings are planted in

a line or square pattern mechanical weeding is possible. With mechanical weeding the soil is being aerated by the weeding and the weeds are kept in the field (worked into the soil, functioning like an organic fertilizer), which may result in a greater root and canopy growth.

6. *Application of compost, to the extent possible*
   Mostly there are no chemical fertilisers available or they are much too expensive for (small) farmers. So instead compost can be used as a fertiliser. Compost has the advantage of creating a better soil structure and improvement of the microbial populations and biodiversity in the soil. Beside that compost also releases its nutrients slower than chemical fertilisers, so they are used more efficiently with less loss.

Nowadays, there still remains scepticism about SRI among scientists, as SRI practices differ greatly from what have been understood to be the optimum conditions and techniques for rice cultivation, in accordance with the crop-improvement paradigm of the Green Revolution (Stoop *et al..*, 2002). After the first published articles supporting and discussing the relevance of the SRI (Uphoff, 1999; Uphoff *et al..*, 2002b; Stoop *et al..*, 2002), several articles by sceptics of the SRI followed (Moser & Barret, 2003; Doberman, 2004; Sheehy *et al..*, 2004). Moser & Barrett (2003) concluded that the SRI is too labour intensive for the small, poorer farmers, for whom the opportunity cost of labour is too high and he explained in this way the low adoption and high disadoption rates they found in parts of Madagascar. Dobermann (2004) concludes that the promising results from the SRI in Madagascar were merely a result of location specific poor soils with Fe-toxicity potential and differences between SRI and conventional are no longer perceptible in the case of fertile rice soils. Sheehy et al.. (2004) used a combination of experiments and modelling to calculate the possibility of the high yields in Madagascar. They concluded "the SRI has no major role in improving rice production generally" and "the extraordinary high yields obtained using SRI in Madagascar are probably the consequence of some form of measurement error". Stoop & Kassam (2005) give a reaction to the 'against' publications on SRI with an article in which they give their remarks on these publication, discuss the controversy about SRI and defend the relevance of the SRI. In this article they mention that SRI "cannot be considered a fixed and/or standardized type of technology" and "is very unlike a 'simple', single component technology". In an earlier article (Stoop *et al..*, 2002) it is already discussed that SRI is more like "a strategy and a set of principles for enhancing plant growth performance and productivity than a specific technology to be applied in a standardized manner" and that in case of the practices of the SRI "synergies are the critical element". SRI has been tested and proven successful in several rice producing areas of the world and thus Stoop

& Kassam claim that the complex SRI, with its synergistic elements, can not be explained by single standardized conventional field experiments and conventional theoretical knowledge. To explain the SRI in a scientific way, further research has to be carried out, before to discard the possible usefulness of the SRI on bases of incomplete or even wrong conclusions from first short-term experimental work.

In Tamil Nadu the System of Rice Intensification was taken cognisance of and introduced by Dr. T.M. Thiyagarajan, at the time Director of the Center for Crop and Soil Management of the Tamil Nadu Agricultural University. He learned about the SRI through contact with a colleague from Wageningen University, who pointed out to him a possible interesting option of the SRI for Tamil Nadu and India. Dr. T.M. Thiyagarajan started several small initial experiments on own initiative and to his surprise he found some first interesting results. From there one he started to set up the first field experiments. With further field experiments and his efforts in promoting the SRI in Tamil Nadu, in 2003 Dr. T.M. Thiyagarajan was able to get permission and fundings for a State Plan Scheme "System of Rice Intensification – implementation in Tambirabarani tract and Cauvery Delta zone", consisting of on-farm trials (Adaptive Research Trials) in the two major rice-growing regions of the state. The results of a total of four field experiments and the Adaptive Research Trials of the State Plan Scheme are gathered and summarized in one paper (Thiyagarajan *et al.*, 2005).

1.5 The objectives of the study and research questions

The overall objective of this study is to give a first, broader description and analysis of the present situation of the socio-technical rice cultivation environment in Tamil Nadu. This is done from the perception that ostensible, purely technical agricultural problems are socially constructed as well. Therefore the need for a more interdisciplinary and participatory way of research, technology development and solution building is being emphasized.

The focus of this research are the rice farmers, the problem of limited and irregular availability of water for crop irrigation and the newly introduced System of Rice Intensification. An attempt is being made with this research to give a better understanding about the present problems in the rice cultivation environment in Tamil Nadu, with including the socio-technical interactions. The research is carried out from a technographic point of view, by data gathered from surveys / interviews / observations with farmers, governmental officials and by literature research. The specific objectives are:

- To analyse and understand farmers' present situation and actions under the local conditions;
- To identify farmers' relations with other actors and elements of the rice cultivation environment and their interactions;
- To identify / predict the successfulness of farmers' implementation of the SRI as a solution to the current problem of limited and irregular availability of water for crop irrigation.

The succeeding research questions are formulated as following:

- How and why do farmers act like they do under the present local conditions?
- What are the relations of farmers with other actors and elements in the rice cultivation environment and how do they interact with each other?
- What is the expectation of a successful farmers' implementation of the SRI as a solution to the current problem of limited and irregular availability of water for crop irrigation?

2 Theory and Analytical Framework

2.1 Introduction

This study is about a description and analysis of the present rice cultivation environment in Tamil Nadu, with a main focus on the rice farmers, the problem of limited and irregular availability of water for crop irrigation and the newly introduced System of Rice Intensification. There is an interaction field between technology and social factors within the rice cultivation environment. The farmers are at the centre of this interaction, especially involving the problem of limited and irregular availability of water for crop irrigation and its possible solutions. One promising possible solution to this problem is the System of Rice Intensification. The actual aim is to look beyond merely the technical aspects and to take also into account the related social field in which the rice cultivation is being practiced.

The SRI is a rice cultivation innovation which is recently introduced in Tamil Nadu and thus is in general unfamiliar to the farmers. Accordingly it should be understood how the diffusion of an innovation within a social system takes place and thus where to pay attention to with the possible diffusion process of the SRI. Therefore use is made of the diffusion theory of Rogers, which is explained in section 2.2. Subsequently, the farming activities that farmers practice are a result of the interaction with their natural environment. The skills that farmers develop themselves depend on the specific environmental conditions in which they are practicing agriculture. This comprehends a process of learning, in which farmers learn how to deal in the best way with the (changing) environmental constraints and opportunities to reach their objectives. This process of learning is at the basis of indigenous knowledge. However, this principle is not included in Rogers' diffusion theory and therefore it could be a useful addition. When a new technology is introduced in a certain area, use should be made of the available indigenous knowledge to adjust it to the local conditions, instead of introducing it as a general practicable developed technology. To find out how indigenous agricultural knowledge and the process of learning is present within the farmer community in Tamil Nadu, firstly more should be understood about this concept in section 2.3. In section 2.4 the sociological perspective that is being followed in this research, the Critical Realism, is being explained. In the end, all the approaches, theories and concepts discussed in this section can be combined in the socio-technical approach called technography. This approach is being used to understand farmers' present situation, actions, and relations to other actors and elements, to identify their position in the full socio-technical field of the rice cultivation environment in Tamil Nadu. With this approach an attempt is made to understand the present problems in the agricultural sector from a broader view, to finally be able to come to more structural solutions. The technographical approach is explained in section 2.5.

2.2 Diffusion of innovations

In the field of diffusion studies it is especially Rogers who has contributed a major part to the research and literature in this branch of science. His latest work 'diffusion of innovations' (Rogers, 2003), a fifth revisited and updated edition, comprises a complete description of all the facets of the diffusion of innovations, including his diffusion theory. The main aspects of this theory are discussed in this part.

Diffusion is the process in which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 2003). This definition displays that the diffusion process consists of four main elements: (1) the innovation; (2) the communication channels; (3) time and (4) the social system.

According to Rogers, the different rates of adoption of a certain (technological) innovation depend upon five characteristics of an innovation: (1) relative advantage, the degree to which an idea is perceived better than the idea it supersedes; (2) compatibility, the degree to which an innovation is perceived as being consistent with the existing values, past experiences and needs; (3) complexity, the degree to which an innovation is perceived difficult to understand and use; (4) trialability, the degree to which an innovation may be experimented with on a limited basis; and (5) observabiltity, the degree to which the results of an innovation are visible to others.

With communication channels a distinction can be made between mass media and interpersonal channels. Mass media has as an advantage that it can rapidly spread initial knowledge and awareness of a new innovation to a large group of potential adopters. But Rogers discusses that interpersonal exchange is more effective in convincing potential adopters, because it is a more subjective, interactive and familiar way of communication. Innovators, early adopters and opinion leaders play an important role in communicating a new innovation. The adoption of a new innovation goes together with a certain extent of uncertainty and risk. Innovators, the first users of a new innovation, have relatively little information about a new innovation and its consequences. The first available information is often only in the from of scientific studies, spread by the mass media. Innovators are daredevils and are able to take a certain amount of risk. Early adopters are less venturesome and base their adoption decisions on bases of the first practical results provided by the innovators. The opinion leaders will base their decisions on observations of the effectiveness and success of the innovation implementation by the innovators and early adopters. From there on the majority of the other adopters will follow. With the communication on innovations between individuals, transfer of ideas between similar individuals (belief, education, socio-economic status, etc.) (homophily) has a higher diffusion effect than between individuals that are quite different (heterophily). The problem that often occurs with diffusion of new innovations is the fact that participants, especially in the beginning phase of diffusion, are quite heterophilous.

In general, the diffusion of a new innovation in time according the number of adopters has an S-shaped curve. The innovators, early adopters, and opinion leaders (left-hand tail) will create the basis for the majority to adopt, with still a few late adopters and laggards who first stay behind because they are not fully convinced and have their doubts about the new innovation (right-hand tail). In the innovation decision process of an individual five steps can be distinguished: (1) knowledge, learning of the innovation's existence and first idea about how it functions; (2) persuasion, forming a favourable or unfavourable attitude towards the innovation; (3) decision, engaging in activities that lead to a choice to adopt or reject the innovation; (4) implementation, putting an innovation into use; and (5) confirmation, revisiting the innovation-decision already made when exposed to new information about it. The decision making is a process of obtaining information about the innovation, to gradually decrease the uncertainty about it to make a considered decision.

The process of diffusion of an innovation occurs within, and changes, a social system. Therefore the characteristics of the social system are an important factor in the diffusion path. The norms and values of a social system can facilitate or complicate the diffusion process and influences the individual decision making. The opinion leaders in the social system have an important role, because they serve as a model and represent the structure of the social system and are able to influence other individual members of the social system.

If an innovation is being introduced deliberately, this is normally done by change agents. Change agents are usually professionals with a university degree, which make use of opinion leaders for the spread of the innovation. Because of the social status of change agents, which makes them heterophilous from the social environment in which they work, they employ normally more homophilous aides for intensively contact with the aimed adopters. Extension departments are an example of such a change agency.

The remark that should be made here is that the diffusion theory of Rogers is formulated in a very general way. But this was also Rogers' initial intention, a general theory that is applicable to the full field of innovation diffusion. But nevertheless, it should also be kept in mind that in specific cases / areas, although it creates a good basis, this is not the only suitable theory. Rogers treats an innovation very unambiguous, as something with a distinct inventor and with the assumption of initial ignorance of its adopters. For many innovations this is applicable (e.g. for technical innovations like the personal computer), but especially in the field of agriculture such presumptions are not always the reality. This will be made clear in the next section with the concept of indigenous agricultural knowledge, a concept not included in Rogers' diffusion theory.

2.3 Indigenous agricultural knowledge

The concept of indigenous agricultural knowledge gained prevalence in agricultural research, when several development researchers started to see that the knowledge which western colonialist were introducing during the end of the 19^{th} century and beginning of the 20^{th} century in their tropical colonies did not take into account the local specific characteristic environmental conditions; i.e. the technologies and principles developed by the colonialists in their home countries, under temperate climates, were supposed to have a general applicability character and were delivered as ready-to-use packages, but when introduced in the tropical colonies to solve problems they even created more problems instead of solving them. Although colonial researchers were aware of the farming systems of the local farmers, to them they seemed 'backwards' and 'primitive'. They put them aside to transfer their more 'advanced' and 'civil' technologies to the local farmers. Unfortunately, they were blinkered by the unfamiliar agricultural practices and to the fact that farmers, in a process of learning, had developed their own ways of optimising production under local environmental conditions, in which they became skilful to a large extent and which was handed down from generation to generation. If the colonial researchers had been aware of this fact, they could have made use of the local knowledge farmers had been developing for several generations to develop agriculture and solve location specific problems in a more successful way.

One of the first to give a clear description of the principle of indigenous agricultural knowledge is a study on rice farming in West Africa by Richards (1985). Richards discusses the universal character of science and formulates the problems related to indigenous agricultural knowledge in a general way, and he even rises an answer:

> "Intellectuals, development agencies and Governments have all pursued environmental management problems too high a level of abstraction and generalization. Many environmental problems are, in fact, localized and specific, and require local, ecologically particular, responses.
> [Richards proposes as a solution] Mobilizing and building upon existing local skills and initiatives […] to stimulate vigorous 'indigenous science' and 'indigenous technology" (Richards, 1985)

Indigenous agricultural knowledge is gained by farmers through a process of learning. In order to reach their (personal) goals, farmers develop their own skills for making use of their environment by developing, testing and improving practices. In this developing process, knowledge about the environmental conditions and resources are acquired. When a certain practice seems successful, the knowledge will be passed on to next generations and it will be further improved according to the changing local environment and newly gained knowledge. In this way, indigenous agricultural knowledge is socially and culturally constructed and has a local character.

During the last decades, the role of indigenous agricultural knowledge is being recognised more and more by agricultural researchers. Nowadays it is no longer the gap between 'advanced' western colonialist and the 'primitive' peasantry, but in more general between scientists and farmers, between theory and practice. The main question is how to best integrate indigenous and scientific knowledge; i.e. how to get the best results from a combination of modern science and traditional local techniques. Scientists aim to develop technologies that can be used on a large scale, under a large range of environmental conditions and that are highly productive. They do this mainly in a theoretical way in accordance with the rules of science. In tropical development countries the majority of the farmers are small farmers, cropping at least partly for household consumption, and under environmental circumstances diverging from one area to another, not only in climatic conditions, but also in availability of resources and social construction. Rural farmers have gained own knowledge and skills for the specific location where they are practicing agriculture and are aware of the cultivation limitations and opportunities at that place. They do this in a practical way by what they perceive; farmers make their points on the ground, not on paper (Richards, 1985). Furthermore, highly productive technologies normally go together with higher risks, which is something most small farmers cannot afford to take. To them the element of the highest possible production is not the most important; a stable livelihood is. In this way too often mismatches occur between what scientists produce and what farmers accept.

To make development or resolving of problems possible and successful in the tropical rural areas, in the research methodology a combination of scientists' knowledge and farmers' knowledge is essential or even inevitable. Scientists should not only stick to the available scientific literature, experiments and theories, but should go into the field with the farmers to learn how farmers cope with local conditions. They should profit from the indigenous agricultural knowledge that has been developed by the farmers, to get a better understanding about the local conditions. Furthermore, scientists should try to understand the decision making process of the farmers, before trying to improve it. In the end this will lead to an integration of the available scientific knowledge and indigenous knowledge with a more promising outcome.

In Tamil Nadu the System of Rice Intensification brought about a situation of the introduction of a new technology developed under different circumstances and for specific reasons elsewhere in the world (Madagascar). To prevent relapsing into the same mistakes made before in history, as discussed above, local conditions (both environmental and social) should be taken into consideration with the introduction of the System of Rice Intensification. Participation between science and practice, i.e. between researchers and farmers, to understand and make use of the local conditions, is a necessity for a successful introduction of the new technology.

Two appropriate and related approaches that provide a good basis to explore the interacting technological / scientific and social fields are 'critical realism' and 'technography'. These approaches are explained in the next two sections.

2.4 Critical Realism

Critical Realism as a new paradigm is being discussed among sociologists and philosophers since the beginning of the new millennium and is considered as the would-be successor of Postmodernism.

The Critical Realism view on science combines the perspectives of that there is a single rational truth, an objective reality, and that science is social constructed, meaning that reality is composed of human discourses or perceptions; i.e. in many cases we are not yet in the position to have knowledge on the scientific objective reality and up to there the reality is explained in different ways. A plurality of ways of looking does not translate into a plurality of ways of knowing (Caldwell, 2003). The view and explanation on the 'truth' is being revisited when knowledge is developing, with the eventual aim of discovering the real truth, the objective reality. Science cannot manage without a concept of truth; there is a pre-existing external reality about which it is the job of science to tell us (Caldwell, 2003).

In this way Critical Realism is an interdisciplinary, semi quantitative approach between hard science and soft science. It assumes that there is a reality, a truth, but that it may be hard to find and that it can be explained in different ways. The objective reality is a form of rationalism that is embedded in society. Whether and when the truth, the mechanisms, declares its presence depends on context and output (Richards, 2004b). Critical Realism can be used to find the underlying mechanisms that are causing problems, that are causing certain behaviour and which explain certain processes. In this way it turns away from the soft science based Postmodernism thinking that there is no single reality, but that there are different ones and all equally valuable; that the reality is being interpreted and constructed differently by people and reality is entirely composed of the human discourses about it. It also turns away from the hard science and rationalistic based Positivism thinking, which assumes that reality exists but also that cause could only have one outcome (if "A", then always expected "B") (Richards, 2004b).

Farmers and scientists look in different ways at problems, interpreting them differently, but in the end there is only one truth, one initial mechanism, causing the problem. Striving for discovering this truth, will make it easier to understand the occurring problems and will help in finding specific suitable solutions for the different groups involved. In the attempt arriving at the single truth, is important to combine the different perceptions of dissimilar individuals or groups towards the same problem. Only with such a broad view, from viewpoints with different perspectives, the search for the underlying truth, the mechanisms, could have a successful outcome. Furthermore, with the insights gained during this process problems can be solved in a way suitable to all social groups involved.

2.5 Technography

Technography is an approach that is being used to describe the basic field within which technological interventions take place. It is an attempt to map the elements, actors and processes in such a way that the analyst is able to look beyond the technology itself to the problems the technological applications are supposed to solve, and to understand what parties and interests should be mobilised in arriving at solutions (Richards, 2004a). The basic aim of the approach is diagnostic. Questions that could be asked are: What is the nature of the problem? What are the key processes and elements? Which social groups are involved? Does this or that technology provide solutions?

No technology stands alone. Technologies are designed by people and are embedded in societies; the technology influences the society and the society influences the technology. Therefore, no technology can be fully understood unless the social dimensions are specified as well. In general the elements of a social-technical system can be classified in functional (stakeholders, machines, processes, materials, etc.) and social elements (values, customs, modalities, economics, politics, etc.). Because of the diversity within the social-technical system, there exists no single methodology to give a description and explanation. Therefore Technography is always methodological plural, using approaches from different branches of science. To make this more straightforward, with a technograpy it should always be possible to differentiate the elements tool, machine, organism and social group, and explain the interactions among them (Richards, 2004a).

Technography aims not at complete description; it aims at gathering enough relevant information to understand in broad outline the interactions between the elements within the socio-technical system or process. The basic questions that have to be covered are: (1) identifying the key elements of the socio-technical system; (2) understanding interaction among the elements; (3) explain how the socio-technical system is limited (occurring problems) and (if relevant) how can it be improved. In the end, a technography is supposed to feed or catalyse design work and actual experimentation (Richards, 2004a).

A technography provides an approach that is broad enough to explore a wide range of problems and solutions and to give a thorough description and analysis of the different interacting elements in a social-technical environment. With taking into account both technical and social components, it is able to define were the actual problems and solutions are located within the socio-technical spectrum. Through this approach the major mechanisms underlying the situation can be revealed.

3 Methodology

3.1 Data gathering

Farm surveys were conducted during the period August – October 2004 in the Tambiraparani river basin (Tirunelveli and Tuticorin Districts; Tamil Nadu), in close collaboration with the first phase of the PhD-project "Design of integrated rice-based farming systems for resource poor farmers to enhance farm productivity", carried out by K. Senthilkumar (PhD, Wageningen University).

Two different questionnaires were used for the farm surveys, i.e. a typology questionnaire and a technography questionnaire. The typology questionnaire, a questionnaire consisting of general questions about farm characteristics, was used to interview 100 farmers for the purpose of a farm typology (appendix C). Of these 100 farmers, 25 farmers were also interviewed with the technography questionnaire, a comprehensive questionnaire consisting of a broad range of questions about technical and social aspects of farming, for the purpose of a technographical analysis with the main focus on rice cultivation, the problem of limited and irregular availability of water for crop irrigation in Tamil Nadu and the System of Rice Intensification (appendix D). The typology questionnaire interviews with the farmers were in the form of a quick question-answer interview, as opposed to the technography questionnaire interviews, which were in the form of an informal conversation with additional questions asked, farmers' anecdotes and sometimes more than one farmer present. The actual technography questionnaire consisted merely of several initial questions as a starting point for the actual interview / conversation with the farmers, which mostly took several hours. Because the farmers were visited at their homes or fields for the interview, also a good impression about the farmers' everyday life environment and situation could be made.

From the 100 farmers, 35 typology surveys were conducted with farmers selected randomly from an existing list of 100 farms situated in the Tambirabarani river basin in the Tirunelveli and Tuticorin districts, provided by Agricultural College & Research Institute Killikulam. Of these 35 farmers, 18 farmers were interviewed with the technography questionnaire. These farmers were part of the 2003 State Plan Scheme "System of Rice Intensification – implementation in Tambirabarani tract and Cauvery Delta zone". The Joint Director of Agriculture (Directorate of Agriculture) of the Tirunelveli and Tuticorin districts selected the 100 farmers for this project. Within this project SRI trainings and farm field trials were conducted to study the farmer field performance of the System of Rice Intensification. Using these farmers as a main source for the technographical farm surveys provided a group of farmers with first experience in the SRI. The remaining 65 farmer typology surveys were conducted with farmers not part of the State Plan Scheme. These farmers were selected randomly by enquiring local people in villages if rice growing farmers were prepared to participate. Of these 65 farmers, 7 farmers were interviewed with the technography questionnaire.

Except from knowing that the farmers were cropping at least one rice crop a year, beforehand nothing was known about the characteristics of their farm and farm activities. The locations of the sample farms within the Tambiraparani rivers basin are roughly displayed below in figure 3.1.

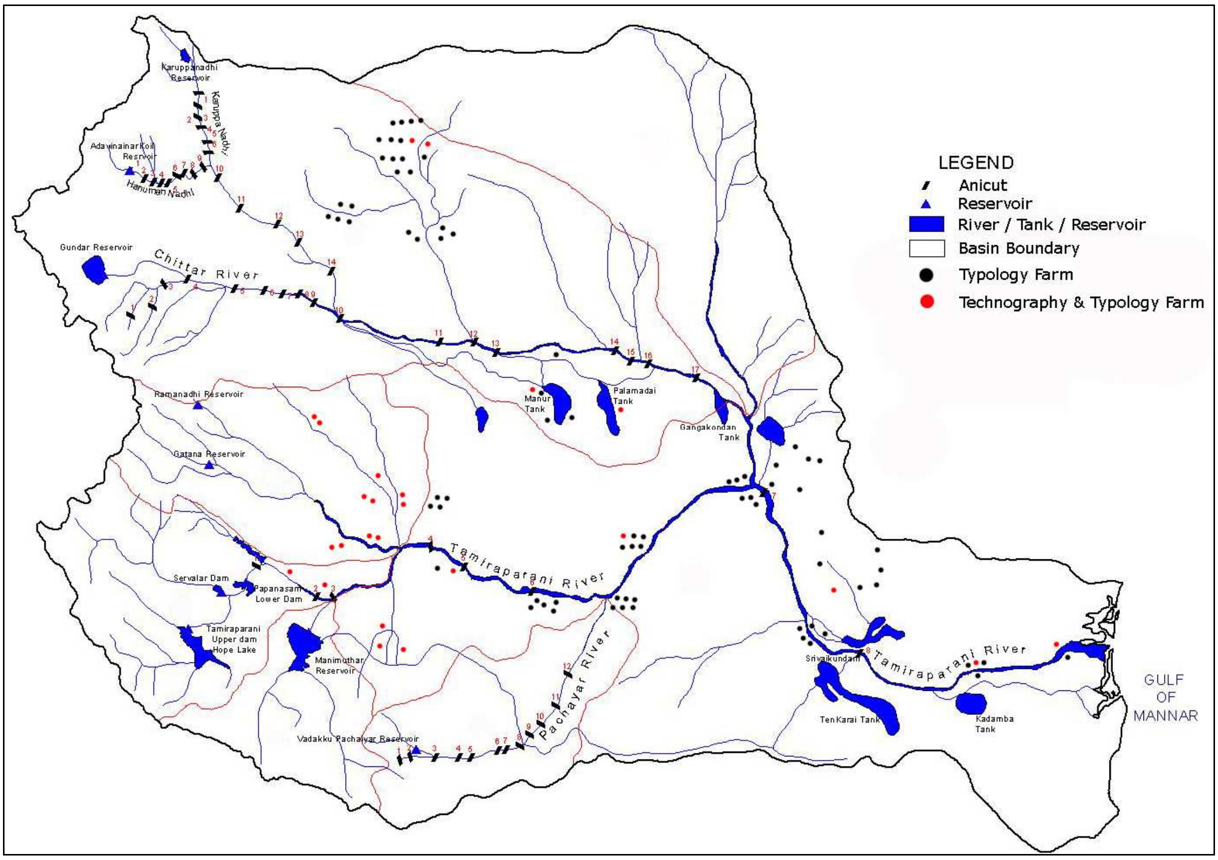

Figure 3.1: Location of survey farms within the Tambiraparani river basin

Next to the farm surveys, interviews and conversations with officials from Government departments were conducted for better understanding the broader picture and situation in which the farmers are interwoven, namely interviews at: office of Assistant Director of Agriculture Tiruchendur (extension), office of Assistant Director of Agriculture Tirunelveli (extension), office of Executive Engineer of Tambiraparani Division and office of Assistant Executive Engineer of Agricultural Engineering Tirunelveli. In the interviews and conversations the relation to the farmers and the limited and irregular availability of water for crop irrigation were emphasized. The Government departments were selected based on the farm surveys, while they were mentioned by the farmers during the technography interviews. Accordingly it became clear which departments are of importance to the farmers. Furthermore there were several informal conversations with the Dean and several professors of Agricultural College & Research Institute Killikulam, the location from where the research was conducted. Also a farmer meeting (farmer irrigation associations) with the District Collector of Tuticorin and a three day farmers' field visit in Thanjavur and Tiruchirappalli (Cauvery Delta area) were attended. All farm and Government department interviews were conducted in Tamil and were translated by K. Senthilkumar to English. Reading regularly the local newspaper 'The Hindu' also helped to gather some additional background information, while articles on agriculture matters could be found daily (appendix G).

3.2 Difficulties

First of all it should be mentioned that time was limited for the data collection (about 15 weeks), especially with only two researchers available for collecting the data and with limited resources available. Furthermore, almost all surveys and interviews (especially the farm surveys) had to be translated from Tamil into English, so there was a dependency on K. Senthilkumar's availability and presence for translation. Next to this, both researchers were engaged in their own research thesis. Unexpected was the long time span needed for arranging and executing the surveys and interviews: farmers were not always present or available for an appointment or had to be searched for in their fields; sometimes long distances had to be travelled to reach the farmers; arranging appointments with Government officials took a lot of preceding paperwork or visits, and gathering the actual information from Government departments was not an easy task. The Government official had to be interviewed during their busy working hours and because of the strict hierarchical structure and the formal reticent attitude it was often difficult to get access to the right persons, to get to the actual essence of the questions and to unravel the right information needed.

Furthermore, at the research location there was no supervision from an expert in this kind of research subject (social based research), which was often difficult in the case of getting proper advice on additional research methods. Therefore much of the research is based on own insight and at distance expertise from the thesis supervisor from Wageningen University in The Netherlands.

Executing a comprehensive literature research at the research location was also difficult, while up to date literature was not available, hard to get hold of and internet access was limited. Furthermore, some of the literature was written in Tamil language. Therefore, a literature research had to be conducted in The Netherlands after returning from Tamil Nadu, India.

3.3 Data analysis

3.3.1 Typology

The farm typology has been carried out in collaboration with the PhD-project of K. Senthilkumar. Within the PhD-project the typology farm surveys were the first phase of his project, consisting of an inventory of characteristics of the farms in the research area. The data collected with the 100 farm surveys were used to analyse the complex reality of farm characteristics, from a holistic approach with considering multiple farm variables, and classifying farms with the same main characteristics in categories (Senthilkumar, 2005). This is done through a farm typology, resulting in the formulation of different farm types. These farm types are used within the PhD-project of K. Senthilkumar to select several farms from each type to do further detailed on-farm surveys and experiments to eventually develop a Multiple Goal Linear Programming (MGLP) farm model.

The data gathered with the typology questionnaires, were converted into a quantitative data sheet insofar as possible (appendix E). In the data sheet some farm characteristics from the questionnaire were not taken into account, mainly because there were no big variations between the farms (farm family male / female; area leased in / out; homestead; inputs), but also because it was difficult to quantify them (crops cultivated; cropping pattern; sketch of farm). In case of the cropping pattern, only the number of rice crops a year is quantified in the typology data sheet. Furthermore, some answers of farmers should be handled with some sceptics, as farmers were not always willing to answer certain questions (income level) or were probably answering it in their advantage (water availability enough?).

The typology data sheet, was analysed through a Principal Components Analysis (PCA) using a statistical package[1] (for more details: Senthilkumar, 2005). From the results of the PCA, the top four principal components[2] were identified, resulting in four main farm types. Because several survey farms can be categorized in more than one farm type, because of overlapping characteristics, for each farm type the six farms with the highest category ranking percentages were selected to calculate the averages for the farm characteristics of each farm type (Senthilkumar, 2005).

Within this thesis the farm typology is also used, but for a different purpose. Because each farmer and farm can be characterized differently, the farm typology is used to structure the complex reality of the farmer community into a workable set of typical farm types, according to quantitative characteristics. A typology makes it possible to

1) Canoco for windows, version 4.5 at Plant Research International, Wageningen UR, The Netherlands
2) PCA transforms a number of correlated variables into a smaller number of uncorrelated variables, called principal components (Senthilkumar, 2005)

analyse the farmer community in the study area in a more structured way, so outcomes can be drawn for different 'parts' of the same community. This in contrary to analysing a farmer community as a whole, despite differences between the members of the farmer community clearly exists. Although, the remark has to be made that this will not exclude the fact that a farm can be categorized in more than one farm type, or that this is the only possible formable farm categorisation. Furthermore, this farm typology is merely a static representations and therefore the formulation of this farm typology could be different in the future. Nevertheless it creates a more simplified and clear view on the complex farmer community instead. The outcomes of the technography create more long term conclusions in a more qualitative way. Therefore the typology and technography supplement one another.

3.3.2 Technography

Whereas the typology focuses mainly on specific farm characteristics, in a straightforward and quantitative way, and formulated based on point-in-time data, the technography has a broader, qualitative and dynamic focus on the socio-technical aspects of farming. In accordance to the theory of a Technography and the Critical Realism perspective, displayed in chapter 2, the attention is beyond merely the technology of the cultivation of rice and includes the (social) environment by which it is surrounded, in which technological interactions take place. Therefore, the opinions and views of the farmers given during the interviews were of great importance in this part of the research and played a major role in analysing the present farming environment in the study area. Additionally, the interviews at the Government departments gave more insight into the interactions and functioning of different departments of importance to the farmers, from a different viewpoint and at a higher level.

The technography questionnaires were mainly based on the cultivation of rice, the problem of limited and irregular availability of water for crop irrigation, the newly introduced System of Rice Intensification, and farmers' situation and relations to other farmers, stakeholders and Government. However, the questionnaires consisted merely of several initial questions as a starting point for the actual interview. Therefore also related aspects, that were not part of the initial questionnaire, were discussed with the farmers.

The data results of the typology questionnaires are structured by different topics. Each topic summarizes several related questions from the original technography questionnaire or summarizes other related aspects, which were not part of the original questionnaire but which were mentioned and explained by the farmers. Therefore, the different topics display the main aspects and problems of rice cultivation in the study area that are of importance to the farmers and thus which determine farmers' behaviour and actions.

4 Survey Results

4.1 Introduction

The results displayed below are the outcome of structuring the data gathered with the 100 typology questionnaires, 25 technography questionnaires, and interviews at Government departments. The chapter is divided in three main parts: Farm typology, Farmers' perspectives and Government perspective. The 100 typology questionnaires, the 25 technography questionnaires and the interviews with Government officials have been used for the Farm typology, Farmers' perspective and Government perspective sections, respectively.

The farm typology is used to structure the complex reality of the farmer community into a workable set of typical farm types, according to quantitative characteristics. Separate from this, with the farmers' perspectives and Government perspective an attempt is made to give a qualitative description of farmers' present situation and actions within the socio-technical rice cultivation environment of the Tambiraparani river basin area, according to the available data and mainly based on the opinions, stories and answers of the farmers. In the Discussion & conclusion chapter the outcomes of the farm typology, farmers' perspectives and Government perspective are brought together to come to the final discussion and conclusion points.

4.2 Farm typology

The rice farmers in the Tambiraparani river basin differ from each other in their personal objectives, goals and access to and availability of resources. Because of this, each farm can be characterized differently, without any identical farms present. Hence, instead of working with an infinite number of farm types, a farm typology has been conducted in order to formulate a workable set of farm types. The farm typology structures the complex reality of the farmer community into a workable set of typical farm types. The farm typology categorization resulted in four different main farm types, which are formulated and described below. In table 4.1 several characteristics of the different farm types are quantified and displayed (Senthilkumar, 2005).

Type 1: Commercial

This farm type is characterized by farms with medium landholdings (average of 7.1 ha), high farm wealth level and high level of education. The farmers in this group are traditional large landholders and are engaged in commercial agriculture. The combination of large land areas and good irrigation facilities enables them to generate high income.

The majority of the family members do not work on the farm and permanent labourers are employed to undertake several agricultural activities. In general one person is working fulltime on the farm in the function of farm manager. Furthermore, the farmers are able to purchase certain machinery if necessary.

For livelihood, food and income, there is no full dependency on the yearly farming result, while there are enough savings at disposal for bad years. Besides, half of these farmers are practicing farming as a secondary occupation. In this case, the primary occupation of the farmers is in other enterprises than farming, mostly an own business. The landholding is inherited from their father and in order to keep it a family property they are cultivating it. A small portion of the yield is used for food, but mainly for market sale.

This type of farms have good irrigation sources and facilities at their disposal. They have good access to the Tambiraparani system and in case of water shortages, most of them have an additional well available or they can afford to dig wells or hire pumps. As a result they are able to crop two rice crops a year.

Type 2: Intermediary

This farm type is not of full commercial or subsistence nature and is characterized by intermediate properties. On average the farmers in this group have above average landholdings (average of 4.1 ha) and farm wealth levels. The family size is comparatively high (mostly joint family[1]) and the level of education is low. About half of the family members work on the farm part-time or full-time. Most of the children are attending a school and are only able to help out part-time or not at all with the farm work. Because of the large family size, no additional permanent labourers are needed for undertaking the agricultural practices.

For livelihood, food and income, there is to a certain extent dependency on the yearly farming result, but still with a bad year it is possible for them to survive with savings or stored rice harvests from previous years. Furthermore, usually at least one family member is also earning income through a non-agricultural job.

These farms have mediocre irrigation sources and facilities at their disposal. The majority has access to the Tambiraparani system, with a well as an additional source for irrigation. Some of the farmers are mainly dependent on a well with good water supply for irrigation. Depending on the location of the farm within the Tambiraparani system and the source of irrigation, farmers are able to crop two rice crops a year.

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1) Parents and their children's families living together in one household (different generations). In general the sons' families often staying in the same household. A patriarch is the head of the household.

Type 3: Subsistence; system irrigation

This farm type consists of farmers with marginal landholdings (average of 0.5 ha). Of the total number of farms in Tamil Nadu, about 75% are marginal farmers (appendix A table A.4). The education level and farm wealth are low. Because of the small landholding, there is only fulltime farm work for one person. Other family members only help out at the busy periods.

Farming is very important for their livelihood, especially for food requirements as the farmers will at least try to supply their families with sufficient rice for food. Therefore this farm type is of subsistence nature. While the farmland size is small, income is obtained mainly through off-farm work as an agricultural labourer working in other farms during the busy periods of the season (planting, harvesting and weeding). Children often give up there education opportunities to earn additional income for the family.

The farming activities entirely depend on the availability of irrigation water from the Tambiraparani system. In case of water shortage, the farmers can not afford to dig a well or hire a pump for additional irrigation supply. This makes this type of farm very vulnerable to water shortage, especially in the latter stage of the cropping season, when crop failure due to water shortage is inevitable. This makes it impossible and too risky for most of the farmers to crop two rice crops a year.

Type 4: Subsistence; non-system irrigation

This farm type has an average landholding of 2.1 ha, but the actual farm sizes vary between marginal and semi-medium. The family size is comparatively low (small nuclear family[1]) and education level and farm wealth are low. Because of the small landholding, there is only fulltime farm work for one person. Other family members only help out at the busy periods.

Farming is very important for food and income, but the majority of the family is doing off-farm work as an agricultural labourer working in other farms to obtain income. Farmers will at least try to supply their families with sufficient rice for food. Therefore this farm type is also of subsistence nature. Children often give up there education opportunities to work on the farm or to earn additional income for the family.

The main characteristic of this farm type is the divergent irrigation source. The location of the farms is not within the command area of the Tambiraparani system, and thus they have no access to water from the system. This means that they are fully dependent on wells and rain fed tanks for irrigation. The majority of the farms irrigate their fields both with a rain fed tank and a well as a source. Both sources are unreliable and risky. Most seasons of the year these farmers are forced to leave part of their fields

[1]) Only parents and dependent children living together in one household.

fallow, because of insufficient water for irrigation, except during a successful rainy season. The production risk is high as the availability of water is unsure and only one rice crop per year is possible with a successful rainy season. In the remaining seasons the farmers are able to cultivate cash crops like vegetables and cotton in part of their area with the little water available in the wells. However, the farmers are compared to the other farm types (with other irrigation sources) more capable of controlling the actual irrigation activities.

Table 4.1: Characteristics of the sample farms; averages of all farms and according to farm types

Variable	Average total	Average Type 1	Average Type 2	Average Type 3	Average Type 4
Head of the farm					
Age (yr)	51.1	43.7	57.3	49.0	53.5
Education*	1.44	2.67	1.33	1.17	1.17
Mayor occupation farming (%)	90	50	100	100	100
Farm wealth**	1.68	3.00	2.33	1.00	1.83
Family members					
Persons (#)	5.09	6.83	8.50	5.17	3.83
Education (family average)*	1.54	2.67	1.17	1.50	1.50
Fulltime on-farm workers (%)	17.7	14.6	39.2	12.9	4.3
Part-time on-farm workers (%)	30.6	12.2	11.8	32.3	52.2
No on-farm workers (%)	51.7	73.2	49.0	54.8	43.5
*Farms with permanent laborers (%)****	15	100	0	0	0
Landholding size (ha)	2.27	7.07	4.07	0.54	2.11
Main source of irrigation					
Canal / system tank (%)	47	33	0	100	0
Well (%)	13	0	33	0	0
Rain fed tank (%)	1	0	0	0	17
Canal / system tank & well (%)	20	67	67	0	0
Rain fed tank & well (%)	19	0	0	0	83
Cropping rice 2x per year (%)	40	83	50	17	0

*) 1= 0-8 standard (low); 2= 9-12 standard (medium); 3= college (high)

**) 1= subsistence; 2= average; 3= wealthy

***) Varying between 1- 4 labourers/farm

4.3 Farmers' perspectives

In this section the data gathered with the technography questionnaires are being structured and analysed. According to the available data, an attempt is made to give a qualitative description of farmers' present situation and actions within the socio-technical rice cultivation environment of the Tambiraparani river basin area. The results in this section are mainly based on the opinions, stories and answers of the farmers.

4.3.1 Reasons for rice

Rice is the major crop being cultivated by farmers in the Tambiraparani river basin and is the farmers' main source for food and income. Farmers mention different reasons for cropping rice as their main crop. First of all, rice is the staple food of Tamil Nadu, it is part of almost every meal, and has as crop traditional and cultural values. Farmers are cultivating rice traditionally and the knowledge on cultivation of rice is passed on from generation to generation. Moreover, farmers want to maintain self-sufficiency in the food supply for their family. They will try to crop at least one rice crop a year to fulfil the objective of food self-sufficiency.

Furthermore, farmers are of the opinion that the cultivation of rice is a relatively simple and extensive practice, compared to other crops. The rice cultivation practices are of a simple and basic nature, with which the farmers are fairly acquainted; intensive labour is solely needed during the beginning and the end of the growing season, for transplanting and harvesting respectively; after the crop is established hardly any intensive work has to be done (apart from maintaining irrigation level, several fertilizer gifts and initial weedings); even with minimal crop maintenance after crop establishment, rice will give fairly acceptable yields. A critical period with the cultivation of rice is at transplanting and harvesting periods, when labour availability could cause problems. Most farmers will adapt their cultivation preparations to the date of water release from the dam (apart from well farmers). At the moment the water is released from the dam, all farmers in the area will have access to this water. As a result, all farmers in the area will start planting rice at the same time. Therefore, from one moment to another, there is an explosive labour demand. This is especially a problem for the poorest farmers, while wealthier farms can afford to pay a higher price for labour and can offer direct payment. So their demand can always be fulfilled. Poor farmers (subsistence type) can not afford to pay the high labour prices or offer direct payment, and therefore labour could be a problem to them. But it seems that especially the smaller / poorer farms work together to overcome this problem; i.e. workers from several individual small / poor farms will gather and will work as a group in each successive field of the individual farms. In this way no labour wages have to be paid, with money the farmers don't have. The costs for labour are paid off with returned labour. Furthermore, the work is done in a more efficient way. Therefore time is left for the farmers to work as a paid labourer at the larger / wealthier farms and earn some savings in addition. This situation will repeat itself at the end of the growing season, at harvesting time, while rice crops that are planted at the same date and in the same area under the same conditions, will also ripen at an identical time. Therefore labour demand explodes again at harvest period.

Risk and uncertainty are two reasons for farmers to choose rice as their main crop, while with rice these are relatively low. According to farmers, the rice crop is less likely to be damaged by animals, pests or diseases, and heavy weather conditions (monsoon rainfalls); the rice crop has a relatively short crop growth cycle (100 – 140 days), compared to for example a cash crop like banana (11 months), and therefore farm income, food and thus livelihood is secured within a short time span; and there is a quite secure and stable market for rice, with minimum support prices set by the Government.

Except from the considerations of farmers displayed above, most farmers don't even have another option than to cultivate rice, especially during the north-east monsoon period (October – December). During this period heavy rainfalls occur and large amounts of rain fall down in a short time period. As a result, water damage can be the case with crops other than rice. Furthermore, a majority of the farmers are for irrigation dependent on the Tambiraparani system. The time and amount of water release from the reservoirs into the system is fully controlled by the Water Resource Organisation (PWD) and the system is mainly managed for the irrigation and cultivation of conventional rice. After the water is released into the system, most fields will be flooded and the best option for farmers is to cultivate rice. Even when a farmer wishes to cultivate a different (cash) crop, it is in most cases impossible as access water from neighbouring fields will flood his field as well (field-to-field irrigation). These situations will occur particular in lowland areas. In the highland and well irrigated areas farmers are more capable to control the irrigation or to drain the access water and thus have the option to choose different crops to cultivate, like vegetables or cash crops.

4.3.2 Use of external inputs

The influences of the Green Revolution are clearly present. Every farmer is using high yielding varieties, chemical fertilizers, chemical pesticides and intensive irrigation. These kinds of inputs are usually widely available and can be purchased at private or Governmental shops (Agricultural Extension Centres). Prices at Agricultural Extension Centres are lower as most inputs are subsidised by the Government in these shops. Sometimes the Government is lacking in supplying the Agricultural Extension Centres with the proper inputs at times they are needed (e.g. not enough or unwanted supply of certain rice seeds at the start of the rice cultivation season, delayed supplying with chemical fertilizers). Then the farmers are depend on private distributors for purchasing their inputs, however at higher prices. Farmers inquire advice about the use of the inputs from the Agricultural Extension Officers or Agricultural University, at least if they are aware of the possibility and are able to get in contact with these institutes. The use of organic fertilizers (manure) is low because the supply is scarce and the expenses even more than for chemical fertilizers. The number of cattle is too low to provide manure on a large scale for fertilizing the fields; there are too little fertile meadows to maintain cattle to graze and the majority of the population is vegetarian so there is not a large demand for meat; collecting the manure is difficult as well.

Different rice varieties are used in the Tirunelveli and Thoothukudi districts for the reasons of high yielding or pest and diseases resistance properties, marketing possibilities and taste (as part of the yield is also used for home consumption). Of all the varieties, there are two varieties commonly used: ASD-16 and ADT-36. ASD-16 is a rice variety with bold, short grains and has a high milling percentage. It is argued that this variety gives a lot of energy, less feeling of hunger and can be preserved in cooked form for a long period. Labourers, peoples doing heavy physical work and lower class families will prefer this variety. Furthermore, this variety has a good marketing price and is exported to the neighbouring state Kerala, where in general the population gives preference to this variety for food. The ADT-36 is a rice variety with fine, long grains. It is argued to be a quality variety and upper class families will prefer it. The population of Tamil Nadu, in general, give preference to this variety. Next to these two varieties there are a lot of newly developed, high yielding and pest and disease resistance varieties used by farmers. Local rice research institutes develop regularly new varieties and Agricultural Extension Officers will advice (part of) the farmers on which variety is best suitable for their field (location specific). Changing the varieties regularly is also good for fewer problems with pests and diseases. Some of the other varieties used by the farmers in the districts are: ADT-39, ADT-42, ADT-43, ADT-45, TKM-9 and Ponni.

A disadvantage of the Green Revolution practices is that nowadays the farmers are dependent on the supply of high yielding varieties and the inextricable linked need for chemical fertilizers and pesticides to come to effective yields (i.e. high yielding varieties are usually hybrids and therefore the next generation is infertile, so farmers have to purchase new seeds every year; high yielding varieties will only perform well in combination with the intensive use of other external inputs). All these inputs have to be purchased, with sparse money. Before the Green Revolution practices set in, farmers were independent from the availability of sowing-seed, as they stored part of their harvest as sowing-seed input for the next season. Furthermore, external inputs (chemical fertilizers, pesticides and also water) were used a lot less intensively than they are being used nowadays. The dependency of farmers on external inputs has grown during the years, which puts them in a position of lesser self control over the cultivation.

4.3.3 Financing

Wealthy farmers (commercial and intermediary type) have hardly any problems with financing the needed inputs (seeds, fertilizers, pesticides, labour) for the cultivation of rice. They have enough savings to purchase and pay the needed inputs and thus don not need to issue a loan.

The smaller and non-wealthy farmers (subsistence type), on the contrary, are often struggling to gather enough funds for purchasing the needed inputs to start a rice crop every possible rice season. Because the non-wealthy farmers have hardly any savings, they are especially dependent upon issuing a loan for enabling cultivation of rice. Two possible options for a money loan are available for the farmers: a Government loan (state bank) or a private loan. The Government loan is a safe loan with fair interest rates, but applying for a loan comprehends a lot of paperwork, an initial sum of money for administration costs is needed and the loan level is based on the area and type of crop cultivated. The private loans however are less difficult to issue and are not restricted by area and crop types, but are more risky and exorbitant rates of interest asked for by usurious money lenders are possible. For the marginal (and poor) farmers it is not much profitable to apply for a Government loan, and thus they will rather choose for a private loan instead. When crop failure occurs due to monsoon failure, insufficient water for irrigation or due to other reasons, there will be no farm result and thus no profit to pay off the loan. In case of a Government loan, pay off rules are not extremely strict. Only when several loans are not being paid off, additional applications for loans will be refused until outstanding loans are met. But in case of a private loan, the farmer can be put under a lot of pressure by the money lenders to pay off the loan within a certain length of time. With successive crop failures, the farmer can get into a vicious circle with growing debts. For some farmers this can become such an unbearable burden that several cases of suicide are reported, because of not being able to repay loans (appendix G, article 6). Nowadays, sometimes the Government remits farmers' loans or offer fresh loans when several successive crop failures occur, to guard the marginal, poor farmers from private money lenders (appendix G, article 7 & 8).

With regard to the enrolment of labour for the labour intensive planting and harvesting activities, the marginal and small, poor farmers (subsistence type) are in a disadvantaged position. At the beginning and end of the cropping season, labour demand is high as all the farms need labourers during this same periods. Because wealthy farmers are able to pay higher wages for labour and can also ensure direct payment of the wages, labourers will prefer to work at their fields instead of at the fields of non-wealthy farmers, who cannot promise these conditions.

4.3.4 Dependency on water

Farmers point out that water availability is by far the most uncontrollable and limiting crop production factor. Other factors like fertilizer availability, pest and weed control or even capital or labour availability are less more problematic, while these factors are less limiting and such problems are all solvable to some extent in one way or another. The production factor water is limiting their potential cultivation and therefore their guaranty for livelihood. The availability of water for crop irrigation is determining a great part of the farmers' cultivation decisions and practices. On the basis of the forecast of available irrigation water farmers decide which crop to cultivate, when to start cultivation, which part of their area to cultivate, or even if to cultivate at all. When enough water is available most farmers will at least try to grow rice once a year, to ensure food for their family.

The majority of the farmers feel powerless in overcoming the limited water availability problem. Farmers were asked how they deal with this problem and if they had come up with own solutions to manage the problem of limited water availability. Mostly the farmers just accept the water deficiency, while they saw no other options; no water, no rice / crop cultivation. They would just leave the land (or part of it) fallow, or if they had already started cultivation the crop would be predestined to failure. Then the farmers could only hope for better and sufficient water availability for the next season. If they knew beforehand that water would be not sufficient to complete the full crop growth period, some would decide to crop less water-demanding crops. This sketched situation is especially the case for the marginal and small farmers (subsistence type). The wealthier / larger farms (commercial and intermediary types) will, especially in case of water deficiency during crop growth, at least try to get hold of some additional water to minimize yield reduction or to prevent crop failure. These farmers have access to certain savings, which creates the possibility for them to purchase certain 'tools' to help them out; hiring a diesel pump to access the residue water from a canal or tank, digging a well (normal or tube) or deepen an existing well (digging or expanding with tube well, either downward or sideward) (appendix F, photo 24 – 27). Of course they only choose for such options, if it seems to be profitable and feasible.

When farmers were asked what they suppose the reasons are for the declined and irregular availability of water for crop irrigation, they came up with several possible causes. First of all they mentioned the increasing monsoon failures during the last years. Due to the monsoon failures, water resources are not being recharged and therefore water availability is declining. Furthermore, the water demand has increased; area under irrigation has increased, industries are developing at a fast rate and demand more water for their production processes, and population is still increasing and demanding more qualitative drinking water. Farmers are especially discontented with the fact that more and more stakeholders (industry, municipal supply) are involved in using the Tambiraparani irrigation system as their water source, while the original single purpose of the system was to provide irrigation water for the agricultural sector in the command area (section 1.3.2). They believe that the Government's main goal is no longer supporting the agriculture sector (although 65% of the state's population is dependent on agriculture for a living), but is more aimed at industrial development, with which probably political aims are involved. Farmers are also of the opinion that the Government should invest more in the maintenance and development of the irrigation infrastructure. The current system is old-fashioned and badly maintained (appendix G, article 2,3 and 4). With better maintenance and investments by the Government, water distribution would be more efficient with fewer losses.

4.3.5 System of Rice Intensification

The System of Rice Intensification is a system that was originated in Madagascar. In Madagascar it was further developed especially for resource poor farmers, as an alternative to the slash-and-burn agriculture practiced, to increase rice production under the local conditions. When it seemed that the SRI had promising results in Madagascar, several researchers took notice of it and the SRI was introduced to rice cultivation areas over the world, with promising initial results. There remains many scepticism about the SRI, especially about the fundamental principles and on the introduction of the locally developed SRI as a global system (section 1.4.4).

In Tamil Nadu the System of Rice Intensification was introduced by Dr. T.M. Thiyagarajan of the Tamil Nadu Agricultural University. He learned about the SRI through contact with a colleague from Wageningen University. At that time problems with the limited and irregular availability of water for crop irrigation were already going on in Tamil Nadu and therefore the SRI, with its water-saving practice, was of special interest to Tamil Nadu's rice cultivation.

In Tamil Nadu the SRI was introduced in a (social-technical) environment being different from the farming environment of Madagascar in which it was originally developed. The farming environment of Madagascar is mainly characterized by small, non-wealthy and especially resource poor farmers, with absence of Green Revolution practices. Therefore the development of the SRI in Madagascar was mainly based on increasing rice yields with the minimal local inputs available. No or minimal use was made of external inputs (high yielding varieties, chemical fertilizers, chemical pesticides and intensive irrigation), simply because of the reason they were not available. These conditions caused the initial formulated SRI practices. If this farming environment is compared to the one in Tamil Nadu, the main reasons for the way the SRI was developed in Madagascar seems absent in Tamil Nadu: resource poor farmers and the absence of

Green Revolution practices. If one thing is clearly visible and abound in Tamil Nadu, it is the influence of the Green Revolution. The SRI is merely of interest to Tamil Nadu because of one of its several cultivation practices, the water-saving practice. The other practices are of lesser interest but partly necessarily to come to the desirable results. Therefore the SRI in Tamil Nadu is practiced with the main SRI practices (section 1.4.4), as developed in Madagascar, combined with the already available Green Revolution practices. From the initial experiments and field trials it seems that this combination has promising results for Tamil Nadu, particularly leading to increasing yields with less water use. The question however is if these changes can be considered as the introduction of SRI in Tamil Nadu or as improvements of the Tamil Nadu rice cultivation practices inspired by the SRI. Although this may seem a trivial question, it is important in the light of the discussion about SRI as an (alternative) on-the-shelf technology or as an approach to rice improvement.

Since the introduction of the SRI in Tamil Nadu, the system is being further developed according to the local conditions and environment of the state. Since the introduction, already several additional technological elements, alternative techniques and adjusted cultivation practices were added to the original cultivation practices of the SRI. The most commonly observed are:

- Nursery mat (appendix F, photo 1, 2 & 3); a mat is placed in the nursery and covered with a layer of earth. The rice seeds are sown in this earth. Because the seedlings are transplanted relatively early, the seedlings and their roots are fragile. Because a mat is used, the seedlings can be scooped from the mat, so the roots are still covered in earth and therefore are not damaged during the removal from the nursery. Furthermore the roots are kept moist in this way, before the actual planting in the field takes place. At the field the seedlings are planted with still some soil covered to the roots. Transplanting in this way reduces the exposure of the seedlings to stress and minimizes the damage to the roots. The nursery mat (Modified Rice Mat Nursery) is developed in Tamil Nadu by the SWMRI (Soil and Water Management Research Instiute, Thanjavur) and the TNAU (Tamil Nadu Agricultural University, Coimbatore) in collaboration with the IRRI (International Rice Research Institute, Philippines) (Rajendran, *et al.*; 2004).
- Line and square planting technique (appendix F, photo 15 & 16); most commonly a rope is used for this technique. Two workers will be occupied with moving the rope, while the other workers will plant the seedlings along the line of the rope. With square planting a rope with marks is being used (appendix F, photo 19). Line planting is more common than square planting, while the square planting is experienced as a

more difficult operation. Although, square planting would enable two way mechanical weeding.

- Mechanical weeding; two types of mechanical weeding devices are being used, the rotary weeder and the conoweeder (appendix F, photo 4, 5, 6 & 14). The rotary weeder was originally developed in Japan around the 1960s, the conoweeder is developed by the IRRI, Philippines. Both devices are modified by TNAU scientists and engineers according to the need to suit the local conditions and cost aspects. The conoweeder is somewhat heavier to handle and expensive to purchase, but is more effective than the rotary weeder. Mechanical weeding has several advantages over hand weeding (appendix F, photo 20). First of all it takes fewer workers per area to do the weeding activities. Secondly, with mechanical weeding the weeds are kept in the field, as they are worked into the soil. In this way the weeds function like an organic fertilizer (with conventional hand weeding the weeds are removed from the field). Furthermore, with mechanical weeding the soil aeration is improved, with better root development as a result. Finally, the mechanical weeding also has a change in labour role pattern as a result. Hand weeding is a job done by females, but because the mechanical weeding is a heavy physical job it is done by males instead.
- Direct seeding, drum seeding (appendix F, photo 28 & 29); a few visited farmers (Cauvery delta visit) were experimenting with direct seeding of rice. Both hand direct seeding and drum seeding were observed. The rice seeds were seeded at the same spacing as normally the SRI seedlings are transplanted (line planting). One or two seeds per hill were used (two, to cover the risk of non-germinating seeds). Apart from the direct seeding, all other practices were according to the SRI technique. The farmers interviewed were claiming that this technique even had a better tillering as a result compared to the normal SRI transplanting. Furthermore, no nursery has to be maintained, which has as advantage that even less water (to raise the nursery) and less labour is needed. Also no difficult transplanting techniques have to be practiced as the seeds are just pressed into the soil. As difficulties the farmers pointed out that only the line planting technique is possible (square planting is very difficult) and that washing away of the rice seeds could be a problem. There are not yet experimental results of this alternative practice.
- The SRI was original developed with the use of compost or some other source of organic fertilizer. But as already indicated above, the farmers are all using chemical fertilizers. Chemical fertilizers are commonly available as compared to organic fertilizers, which are paradoxically scarce.
- Because it is difficult to fully control the water management in the fields, it is also difficult for most farmers to fully following the SRI irrigation management practices.

A majority of the sample farms interviewed with the technography questionnaire (18) were part of the 2003 State Plan Scheme "System of Rice Intensification – implementation in Tambirabarani tract and Cauvery Delta zone". Therefore most of the interviewed farmers were known with the System of Rice Intensification. These farmers were instructed with an initial one day SRI training and one season farm field trials were conducted on their fields, so they formed a first opinion about the SRI. In general the state plan scheme farmers were surprised and positive about the SRI and its results after the field trails (higher yields with reduced water usage). Although the positive reactions, still relatively few farmers are practicing the SRI or are planning to switch to the system. If they are practicing SRI, they mostly only use the cultivation technique for a small part of their total area, just for a try out experiment (large wealthy farms; not marginal and small farms, not the subsistence type; because of risk factor). Most farmers say they are not yet familiar enough with the SRI to independently practice the system, or to switch to the SRI entirely in all of their fields. The SRI practices are perceived as difficult and farmers feel not confident in carrying out the cultivation practices without the help from experts from the university. With help from the university, most of them would surely go for the SRI. Farmers would rather trust on familiar rice cultivation practices from which they know what they can expect; with the SRI, farmers are anxious about implementing the practices wrongly, with the risk of crop failure.

The farmers not part of the state plan scheme mostly had not heard of SRI at all. Only a few of them had heard something about the system through an agricultural extension officer, through a source of media or from neighbours, but were not familiar with the principles or advantages. Their attention was not drawn to inquire into the SRI and therefore they continued practicing the conventional methods.

There are several problems, difficulties and differences of the SRI, compared to the conventional rice cultivation, that are mentioned by the farmers. The most important ones are displayed below:

- The SRI nursery practices are defined as difficult by farmers, especially the preparation of the nursery mat. There should be a separate nursery in each field if the different fields are located some distance from each other. The nursery should be close to the field to which the seedlings are supposed to be transplanted, because the transplanting activity should be done as quickly as possible to reduce stress and possibility of dehydration.
- SRI requires more labourers for transplanting and while labour is already scarce because of the high demand at transplanting time, this can be a problem. This makes it also difficult to cultivate SRI rice on a large scale.

- Skilful labourers are needed, because the very young seedlings have to be handled with care and have to be transplanted in a specific way (nursery mat, seedlings have to be planted sideways instead of downwards, line / square planting). Farmers practicing SRI have to search for labourers who already know about the SRI transplanting techniques, or they have to give them proper instructions and hope the labourers will follow these in the right way. Giving the instructions and regulating the work is a time taking activity.
- After transplanting there is some risk with the establishment of the rice seedlings. The transplanted seedlings are very young and fragile and in the first period after planting the possibility exists that a heavy rain will wash the seedlings away.
- It is difficult for farmers to carry out all the operations as prescribed according to the SRI technique, mainly because most farmers cannot entirely regulate the field irrigation (canal irrigated areas, lowlands). The farmers are dependent on the date of water release from the dam for field preparations and time of transplanting. Because the date of water release is never sure, there is uncertainty about the time when the seedlings can be transplanted from the nursery to the field. This makes it difficult to control the seedling age at transplanting time. Furthermore, the farmers cannot practice water-saving techniques without proper control over the irrigation; water release and monsoon rains will flood the fields, leaking water from neighbouring fields practicing conventional techniques will disturb the irrigation practice and excess water will flow to lowland areas.

Next to the above displayed practical problems, farmers also mention the positive elements of the SRI, as compared to the conventional system:

- Because of transplanting single seedlings at wide spacing, lesser seed per area is needed and a smaller nursery can be used. This will reduce the initial costs.
- There is lesser fertilizer and water needed with practicing SRI, which will further reduce the costs.
- A higher yield is experienced by farmers.
- Farmers observe that SRI rice crops look (and are) healthier than conventional rice crops (appendix F, photo 21).
- Female farmers / workers are happy with the fact that with the SRI also the males are willing to do the weeding operations (with the rotary / cone weeder), while with the conventional system weeding is seen as a women’s job (appendix F, photo 6, 14 & 20).

4.3.6 Cooperation among farmers

Although in general the farmers function on individual basis, regarding farming activities, there are certain forms of cooperation and collective activities present in the farming community. In general, the poorer, marginal and small farmers (subsistence type) work together more frequent and intensively than the larger farmers do (commercial type). The larger, commercial type farmers have better access to resources (due to more savings), are less dependent on farming for their livelihood or are practicing farming as a secondary occupation. Therefore they are less dependent on cooperation with other farmers for successful farming for livelihood.

First of all several farmers exchange ideas and information on the cultivation of their crops, give or take advice from each other or will discuss about certain cultivation topics with their neighbouring or village member farmers. Furthermore several farmers observe the activities of farmers' fields surrounding their fields. If it seems that a neighbouring farmer's practice is successful they will consider to adopt the same practice or will inform the farmer about it.

Farmer associations (water users associations) are present in the research area and are arranged according to irrigation structures, regions, villages, or even crops; i.e. arrangement by the dependency of farmers on a certain tank or part of a channel in a certain area, farmers of a same village or region, or farmers cultivating the same crop (all dealing mainly with water management). Mostly these farm associations are formed spontaneously by the farmers themselves. As regards the Tambiraparani river basin, the tail reach of the system has about 90 water users associations, while the head and middle reaches have about 40 (Brewer *et al.*, 1997). The activity, organisation and size varies strongly among the individual farmer associations. The main goal of the farmer associations is to equally divide the available irrigation water among the farmers and to raise questions on local problems to the responsible Government departments (lobbying). They can do this by directly contacting the Government department or through the monthly held 'Farmers Welfare Meeting'. At such a meeting the heads of the farmer associations will be given the opportunity to raise their dissatisfactions to the District Collector on problems that the Government should take care of. The District Collector will decide if the dissatisfaction is justified and will accordingly instruct the responsible Government department, of which an official is present at the meeting.

A common collective activity is the maintenance, clearing and desilting of channels and tanks. The larger part of the irrigation infrastructure is managed by Government departments; the structures located in the direct surrounding of the fields are normally managed by the farmers. Nevertheless, if a Government department is lacking in proper maintenance of channels and tanks in some places, the farmers will also try to fix defects there. The maintenance activities may also be organised through the farmer associations.

Some farmers may also discuss with each other the time and amount of irrigation of their fields, in case different crops are being cultivated (in case of field-to-field irrigation). Also this may be organised through the farmer associations.

Self Help Groups (SHG) for woman are present in the research area. A Self Help Group is a small group of woman in a village, with members belong to the poverty line, are backward financially and/or socially, and some are illiterate. They form a group to create empowerment by helping each other financially and socially. The SHG has one or two leaders. Every month each member of the SHG saves a certain amount of money (in the range of Rs. 50 per month), which is put in de bank. If a member is in the urgent need for money (only for the purpose of income generating or self-employment) the SHG will lend it to her against a very low interest. The founding of SHGs is being encouraged and stimulated by several rural development schemes, initiated by the Government. If the SHGs are performing well (which varies from village to village), the are given the opportunity to take a loan from the bank (Micro Finance). One of the farmers interviewed (farm survey), appeared to be the leader of a SHG for female farmers. This woman took the SRI training that was part of the SRI State Plan Scheme and is now successfully teaching the other members of the SHG how to practice SRI (appendix F, photo 30). From a study on the impact of Self Help Groups on the social/empowerment status of women members in southern India (Myrada, 2002), it seems that members of a SHG emerge as more confident, financially more secure, more in control of their lives, and in a stronger position in relation to their family members.

4.4 Government perspective

In this section the data gathered with the interviews at Government departments is being structured and analysed. Gathering the information from the Government departments was a difficult job (section 3.2). The departments discussed are: Directorate of Agriculture (extension) and Agricultural Engineering, both sub departments of the Agriculture Department; and Engineer in Chief (Water Resources Organisation) & Chief Engineer (General), a sub department of the Public Works Department. Every department formulates and implements major or minor development schemes (both state and central Government initiated schemes) within their responsible fields.

The interview questions were mainly focused on the objectives of the departments, their organisation, their interaction and connection with the farmers and their role in the problem of limited and irregular availability of water. The results in this section are mainly based on the opinions, answers and explanations of the interviewed

Government officials, supplemented with information from received reports from the interviewed officials and the internet page of the Government of Tamil Nadu[1].

4.4.1 Directorate of Agriculture

The Directorate of Agriculture (extension) (also named Agricultural Commissionerate) is part of the Agriculture Department and is organized in different levels, from state level to field level (state level → district level → taluk level → block level → field level). Every organizational level has it's own head, head's assistants, subdivisions with subject matter specialists and civil servants. There is a thorough control and reviewing on the functioning of the different levels from the top to the bottom.

A T&V (Training and Visit) project was implemented in Tamil Nadu from 1981-87, with World Bank assistance, with the objective of strengthening and upgrading the quality of Agricultural Extension provided to the farmers (Directorate of Agriculture, 1992). Although, the T&V system introduced in 1981 was largely crop based and did not provide the integrated extension service required by the farmers as according to the changing trends in Agricultural development, emphasising on optimum utilisation of land and water resources (Directorate of Agriculture, 1992). Furthermore, many of the other agricultural related departments did not posses a well developed extension machinery and thus use could be made of the Agriculture Department extension machinery. Therefore, in 1992 the World Bank assisted an Agricultural Development Programme, which included broad basing of Agricultural Extension (Directorate of Agriculture, 1992). With the implementation of this broad based extension approach concept, the functions of the extension machineries were modified accordingly.

The main objective of the Directorate of Agriculture (extension) is to increase the production and productivity of all agricultural crops. They try to achieve this by transferring the latest technologies to the farmer community. The new technologies developed by scientists of the agricultural university's research institutes are thoroughly tested and finally examined by a Commission of Agriculture, before they are released to the farmers on large scale.

The actual extension implementation is done at the field level by the Agricultural Officer (AO) and the Assistant Agricultural Officer (AAO). The AAO is the person that has direct and intensive contact with the farmers. The AAO has to divide the farmers under his jurisdiction into 8 groups. From each group contact farmers (progressive farmers) are selected up to a number of 10 members. Each of the eight groups is visited by de AAO for a full day once in a two week's period. The main duty of the AAO is to provide farmers with new practices, to convince as many farmers as possible to adopt these practices and

[1]) http://www.tn.gov.in/

to advice farmers on various aspects of cultivation (use and availability of inputs, pest and disease management, agricultural subsidies, etc.). Furthermore the AAO is responsible for keeping records of various kinds (field observations, area coverage, demand for inputs, soil samples, crop damage, etc.) and has to make arrangements for target group meetings, field days, seminars, preseason campaigns, etc. There is a monthly training for the AAOs and a monthly review meeting conducted by the responsible AOs. The AO is responsible for the AAOs in his jurisdiction. He guides them in their activity and controls them according to a schedule on a regular basis.

In the same way the AO is responsible for guiding and controlling the AAOs, the AO is guided and controlled again by another higher official. This system is continued until to the top of the Directorate of Agriculture at state level, which is represented by the Director of Agriculture (DA). Next to this, there is an arrangement in several subdivisions at taluk, district and state level, again controlled by the head of each level.

At Block level Agricultural Extension Centres, headed by an Agricultural Development Officer (ADO), are being managed. It is from these centres that agricultural inputs are divided among the farmers, in consultation with the AOs and AAOs. Furthermore, farmers can visit the Agricultural Extension Centre for (technical) advice.

Because it is impossible to reach all farmers directly, the Directorate of Agriculture (extension) works with a system of contact farmers (progressive farmers). From every AAO’s jurisdiction several progressive farmers are selected. These progressive farmers have intensive contact with the AAOs and are eligible for trainings and field demonstrations. To be selected, the progressive farmers have to meet certain requirements, which are:

- Able to read and write the Tamil language
- Age between 25 and 40
- 33% has to be female
- Selection has to be a mix of all castes

The intention of this system is that the progressive farmers pass on the knowledge they gained at the trainings and demonstrations to other farmers in their village. In this way the extension department hopes to reach a larger part of the farmers. Furthermore, the department also makes use of mass media to spread news on new varieties, technologies or other information among the farmers (newspaper, radio). Nevertheless, in several areas the extension department is still experiencing problems with convincing farmers of new technologies. As a reason is mentioned the farmers’ traditional and conservative way of thinking and thus unwillingness to adopt new technologies. The extension department however lacks the capacity to test these assumptions and to examine what specific reasons farmers have not to engage with some certain technologies.

The SRI is one of the new technologies that is being spread by the Directorate of Agriculture (extension). They contributed in the 2003 State Plan Scheme "System of Rice Intensification – implementation in Tambiraparani tract and Cauvery Delta zone" for which in the Tambiraparani river basin 100 progressive farmers were selected, were given SRI trainings and farm field trials were conducted on their fields. Although the SRI is not yet being introduced and adopted on a large scale, the department is putting more and more emphasis on this new technology. After the first promotion of the SRI with the 2003 State Plan Scheme, now the SRI is also being promoted in other areas of the state (appendix G, article 10). Furthermore, rice cultivation with the SRI is partly subsidised by the Government.

The policies being followed by the Directorate of Agriculture are mainly determined in the upper layers of the Agriculture Department, headed by the Minister of Agriculture. Some of these policies are successful and some are not. Even when at the lower layers of the Directorate of Agriculture (AOs and AAOs) the knowledge is available that certain policies would not be successful, they are implemented nevertheless. As an example was mentioned the excluding of the variety ASD-16 from the assortment of varieties distributed by the Agricultural Extension Centres. As this was seen as an old variety it was replaced with newly developed ones. However, farmers appreciate this variety very much for several of its properties (section 4.3.2) and the AOs and AAOs were aware of this fact. Then when the ASD-16 variety was no longer available at the Agricultural Extension Centres, farmers purchased the ASD-16 rice seeds from private seed companies. Moreover, the AOs and AAOs were accused of not doing their job properly, while large amounts of rice seeds were not sold and remained in the stocks of the Agricultural Extension Centres.

4.4.2 Agricultural Engineering

The Agricultural Engineering department is part of the Agriculture Department and is organized in different levels, from state level to field level, in a likely manner as the Directorate of Agriculture is organised.

The Agricultural Engineering Department is engaged in the conservation, development and management of agricultural land and water resources of the State, with the objective of contributing to the sustainable increase in agricultural production and with efficient use of (rain) water and ensuring adequate supply of water for agriculture as one of its main goals (Agriculture Department, 2005). This is done through prevention of soil erosion, wasteland development, modernisation of the irrigation structures, advising farmers on irrigation practices, promoting farmer associations, and creating and promoting new water-harvesting and irrigation facilities while stabilizing the existing ones. The working area of the Agricultural Engineering department starts were the working area of the Water Resource Organisation Department ends. This is formulised as the area from the sluices of the main channels and tanks up to the farmer's field. Although, in practice there is also some overlap between the departments.

The main current activity of the Agricultural Engineering Department is the cementation of channels in their working area. This activity is financed by the central Government (5/10) , state Government (4/10) and farmer associations (water users associations) (1/10). Because not enough funds are available to cement all the channels fully, they normally only cement the first parts of the channels. In this way everybody can profit from the cemented channels; the efficiency in the first part of the channel is increased and therefore water supply to the latter part of the channel increases as well. After the construction is (partly) finished, the farmer associations receive a one time payment to maintain the channels in their area. The Agricultural Engineering department checks the farm associations if the channels are properly maintained and if the money is used for the right purpose accordingly. Next to cementing channels, the Agricultural Engineering department also gives advice to the farm associations on irrigation and provide them with area specific irrigation schedules, are conducting research on alternative irrigation possibilities, and are constructing water harvest structures (at local / farm level).

A problem that the Agricultural Engineering department has to face is that the cementation of the channels is only possible during periods the irrigation system is not being used (when no crops are being cultivated). This is normally only during the summer period, when the water release is being ceased for several months. Collecting the money from the farmer associations can be a problem as well. Although, with obliging the farmer associations to contribute in the costs, it is assured to a certain extent that the money is used properly (because part of it is the association's).

4.4.3 Water Resource Organisation

The Water Resource Organisation Department (headed by the Engineer in Chief, Water Resource Organisation) is part of the Public Works Department and is from state to district organised in different levels. For the water management in the state the Water Resource Organisation is divided into four main regions, each headed by a regional Chief Engineer. Each region comprehends several river basins, of which each is headed by an Executive Engineer (e.g. Executive Engineer of Tambiraparani Division). From thereon there is a further division according to different parts of the river basins headed by Assistant Executive Engineers, who direct Assistant Engineers and Junior Engineers at the lower levels. At the lowest level so-called Laskars are employed, who are responsible for the operation of channel sluices (Brewer *et al.*, 1997). Furthermore, within the Water Resource Organisation Department there are several supporting sub departments (e.g.

Design, Research & Construction Support; Plan Formulation; Operation and Maintenance; and others) which are headed again by a Chief Engineer accordingly. Besides, every district has a Superintending Engineer.

The main objectives of the Water Resource Organisation Department are the regulation, effective management and distribution of water (to ensure optimum utilization and maximizing production and productivity of all sectors requiring water), operating and maintaining the irrigation systems, and in so far as possible to increase water resources. The working area of the Water Resource Organisation Department is limited to the major and larger irrigation structures (minor irrigation structures is the responsibility of the Agricultural Engineering Department, section 4.4.2).

Concerning the Tambiraparani river basin; since the completion of the Papanasam reservoir in the 1940s, several changes have occurred in the use of water in the system (section 1.3.2) and more recently, since several years, the Water Resource Organisation Department is not able to meet the water demands of the different sectors requiring water anymore. Therefore the department was forced to change the water distribution schemes for agricultural irrigation accordingly (section 1.3.3). Because of (continuing) changes in water use, the original formulised water distribution rules do not match no longer with the changed water uses and discrepancies have occurred (section 1.3.2).

The original purpose of the Tambiraparani system was to provide irrigation water for the agricultural sector. However, as water demand was increasing and gradually other sectors came also into the picture, the priorities of water distribution to the different stakeholders changed as well. The present priority of water distribution given by the Water Resource Organisation Department to the different sectors is in following order: 1) domestic use (drinking water), 2) major industries (thermal power plants), 3) agricultural sector (irrigation) and 4) minor industries. Based on these priorities, predictive calculations of demands and present supplies the Water Resource Organisation Department decides which amount of water is released for the purpose of irrigation in the agricultural sector. Since several years this implies that the amount of water available for the agricultural sector is not enough to meet the full demands. The available water amount is released from head-reach to tail-end of the system and therefore the tail-end farmers are mostly deprived of water for irrigation. The Water Resource Organisation is aware of the fact that this is not a fair way of equal distribution of water and is planning to change this policy. The actual date and time of the release of water (which is important to the farmers for planning their cultivation preparations) is announced by the department (in the newspapers) only shortly before the actual release (only several days in advance).

Until now, there is hardly any direct interaction between farmers and the Water Resource Organisation, but because presently the irrigation in the state is largely affected in view of the shortage in water resources, the Government recognises the importance of cooperation with farmers. Therefore the Government proposed the implementation of an Irrigation Assessment and Action Programme, which issues orders to start Weekly Water Shandy in all irrigation commands to facilitate all the Section Officers and their irrigation staff to implement water management practices in consultation with the farmers (Water Resource Organisation, 2005).

4.4.4 Cooperation among the Government departments

According to the interviews with the Government department officials, it seems that cooperation among the above discussed departments is limited. It appears that the different departments are largely focusing on the topics within their own field and responsibilities, and hardly involve in the activities of the other departments, although they are working on closely related topics. For example, when the Agricultural Engineering Department and Water Resource Organisation Department were asked about the SRI, which is becoming an important topic of the Directorate of Agriculture (extension), it seems that they are not familiar with this system. Moreover, they point out that this is not their responsibility, but is the business of the Directorate of Agriculture. Because of this, discrepancies between the implementation of policies of the different departments arise (e.g. the Directorate of Agriculture has successfully spread the SRI and it's water-saving cultivation technique in a certain area, but the Water Resource Organisation is still releasing amounts of water based on the traditional rice cultivation methods to this area). Normally, the most intensive contact between the different departments is during the monthly held 'Farmers Welfare Meeting' at the District Collector's office, where farmers and farmer associations are given the opportunity to discuss the problems they perceive. Within the Agriculture Department there are held meetings now and then between the sub departments to discuss about problems and solutions in the sector.

The Directorate of Agriculture (extension) collaborates mostly with the Tamil Nadu Agricultural University (TNAU) for the transfer of the latest technologies emanating from the various research programmes of the TNAU to the farming community. The TNAU instructs the extension personnel of the Directorate of Agriculture on the latest technologies through trainings. Furthermore, the TNAU and the Directorate of Agriculture cooperate in providing field demonstrations and farmers' trainings.

4.4.5 Farmers' opinion on the Government departments

During the farm surveys, the farmers gave their opinion on the Government and indicated several dissatisfactions about the functioning or policies being followed. Of course a Government can not satisfy all its citizens and therefore dissatisfactions with

Government performance should be treated with some care. But a Government that does not take its citizens serious, risks being further distanced from its citizens.

First of all, farmers feel treated unfairly in the case of the distribution of water for irrigation. Historically the single purpose of the Tambiraparani system is delivering and distributing water for irrigation to the agricultural sector. However, nowadays the industrial sector and municipals (drinking water) are important competitors and are putting more pressure on the system. Formerly agriculture had first priority in the distribution of water, while nowadays the Government gives first priority to municipal and industrial use of water. Farmers are to a high degree dependent on the water distribution policies for the cultivation of their crops and therefore farmers feel walked out on by the Government's support, although about 65% of the population is dependent on agriculture for a living. Furthermore the farmers are of the opinion that the Government should put more effort in improving the irrigation infrastructure (cement more channels, better distribution regulations, better maintenance, etc.) and should offer better arrangements for Governmental loans (especially in case of the marginal and small farmers). Farmers believe that political aims and benefits are involved at the cost of agriculture.

Concerning the Directorate of Agriculture (extension), the farmers mention that there exists high variety in the quality of the agricultural extension officers (AOs and AAOs). Some are very dedicated, but others are corrupt and are not taking there job seriously. Several farmers in the more backward areas even tell that they have no contact at all with agricultural extension officers. Besides, the supplies of inputs at the Agricultural Extension Centres are regularly lacking (in amount, timely supply and varieties). An interviewed Assistant Director of Agriculture even was of the opinion that the Directorate of Agriculture should change the policies and should privatise the distribution of agricultural inputs (not regulated by the Agricultural Extension Centres) and should only control the quality and the prices. Then the department could focus more on the technical aspects and the farmers.

5 Discussion & Conclusion

5.1 Introduction

This chapter attempts to bring together the major findings of this study with the purpose of understanding the situation of the socio-technical rice cultivation environment in Tamil Nadu. The main focus of this study is on the rice farmers, the present problem of limited and irregular availability of water for crop irrigation, the System of Rice Intensification, and the interactions between these three. Because both social and technological elements are involved and with the conviction that technology is socially constructed, the technography approach (section 2.5) is being followed. A technography provides an approach that is broad enough to give a thorough description and analysis of the different interacting elements of the social-technical environment. It enables the researcher to define were the actual problems and solutions are located within the social-technical spectrum. Therewith it encourages a broader, interdisciplinary and participatory way of research with in the end the goal of developing more suitable and durable solutions and technologies to present problems.

This study has operated at different levels and used different methods of approach. It includes two different farm surveys, interviews at Government departments and a complementary literature research. Although here and there the data are incomplete (section 3.2) the attempt is made to found the judgments formulated in this chapter the best way possible with the available information and data. It is hoped that this study may contribute in some extent to future solutions for the present problems in the agricultural sector of Tamil Nadu and that a first onset is given towards the importance of interdisciplinary and participatory research. This chapter revisits the research questions formulated in section 1.5:

- How and why do farmers act like they do under the present local conditions?
- What are the relations of farmers with other actors and elements in the rice cultivation environment and how do they interact with each other?
- What is the expectation of a successful farmers' implementation of the SRI as a solution to the current problem of limited and irregular availability of water for crop irrigation?

5.2 The need for a stable, secure and developing agricultural sector

Although Tamil Nadu is undergoing fast developments regarding the industrial and service sectors and is one of the most industrialized states of India, the agriculture sector remains to be of great importance to Tamil Nadu. With only a share of 17 % in the Net State Domestic Product (NSDP), still more than 65% of the population depends on the agricultural sector for a living and about 50% of the working population depends on agriculture for employment and income. Agriculture provides employment and livelihood, supplies raw materials to industries and is still needed for the state’s food self-sufficiency and security. Furthermore, with the shift to a significant smaller share of agriculture in the NSDP during the last five decades, without accordingly a shift in the share of workers from the primary sector to the secondary and tertiary sectors, rural poverty has increased. Therefore, a stable, secure and developing agricultural sector is essential for the state’s future self-sufficiency and security of food and poverty alleviation, i.e. for Tamil Nadu’s future development in general.

At the moment the agricultural sector of Tamil Nadu is facing a problem of limited and irregular availability of water for crop irrigation, which currently is the main factor limiting the potential production of crop cultivation, especially in the case of conventional rice. A still further increasing population, a majority of the population being dependent on rice cultivation for employment and livelihood, a declining area under rice and declining rice productivity during the last three years, increasing demands and stagnating supply for water, and rice being the state’s staple food. Therefore, increasing the rice productivity and water use efficiency have become of growing concerns. To stand up to the present problems, a breakthrough of the present stagnation in the agricultural sector has to be accomplished with proper and durable solution building; i.e. thorough considered development in the agricultural sector is needed.

5.3 Beyond technological solutions

Solutions to the present problem of limited and irregular availability of water for crop irrigation should not merely be found in the field of technology. Technology is socially constructed and therefore the focus should be on the broader social-technical environment to come to suitable and durable solutions. One should not see technology as a single solution, but as a part of the complete solution. Yet, it should fit seamlessly with the socio-technical environment in which it is introduced.

Within the social-technical environment all different kinds of actors, elements and stakeholders are active, exerting influence on each other, on technologies and on the social environment as a whole. New technologies should be tested and adapted to the social environment in which they are being introduced. Therefore an attempt should be made to unravel and understand the complex social-technical environment, to come to successful adoption. Furthermore, an attempt should be made to discover what is at the actual basis of the problem, to look beyond the perceived problem with a view from a broader perspective. Case specific technologies that are not taking into account initial causes will mostly only solve part of the actual larger problem or are just temporarily solutions.

Especially with the current introduction of a new promising option, the System of Rice Intensification, use should be made of such a way of research. Solutions should be developed in accordance with the farmers' (social) situation and environment to make technologies or policies successful at the implementation phase. To realize this it should be understood how farmers 'work' under the present local conditions. An attempt should be made to unravel and understand what their motives are for certain behaviour and actions. Furthermore, existing knowledge of farmers about the local conditions should be uncovered and, if available, use should be made of it. With interdisciplinary and participatory research methods, inadequacy between theory and practice of technologies can be overcome, difficulties or incompetence at the implementation phase can be anticipated or prevented, and the need for implementing the new technology at all can be detected.

5.4 How and why farmers act like they do under the present local conditions

The socio-technical rice cultivation environment, in which the farmers are operating, comprehends all kind of factors determining and influencing the farmers' motives for certain behaviour and actions. With this study an attempt is made to unravel and formulate the most important ones. The results of this attempt are displayed in the previous chapters. But nevertheless, even beyond, still a further analysis is needed to come to a workable coherent conclusion. In section 2.4 we formulated the Critical Realism perspective as an addition to the technography approach followed. In this section it was said that Critical Realism tries to find the underlying mechanisms that are causing problems, that are causing certain behaviour and which explain certain processes. This perspective is used here to analyse and clarify how and why farmers act like they do under the present local conditions, through the formulation of a generally valid mechanism. Therefore, the results of the previous chapters have been put to the test. After going through the variety of data gathered, a mechanism explaining the farmers' motives for certain behaviour and actions was formulated, namely: 'risk aversion'. It seems that 'risk' is embedded in many aspects of the rice cultivation in Tamil Nadu, and that 'risk aversion' plays a major role in the farmers' decision making process. In the next section it will be clarified how the analysis arrived at the underlying mechanism 'risk aversion' and how the farmers' decision making process is being influenced by it.

Furthermore, the farmers' innovativeness is being discussed. The farmers' possibility for innovativeness is closely related to the concept of indigenous agricultural knowledge, which was introduced in section 2.3. It was said here that indigenous agricultural knowledge is gained by farmers through a process of learning; in order to reach their (personal) goals, farmers develop their own skills for making use of their environment by developing, testing and improving practices. Such a process goes along with the farmers' possibility for innovativeness. Accordingly something can be said about the farmer's behaviour and actions. Therefore, in the latter part of this section it is examined if such a concept of indigenous agricultural knowledge and innovativeness is present in the farmer society of Tamil Nadu.

5.4.1 Risk aversion as a mechanism

The mechanism 'risk aversion' should be understood as a generic term for a collection of sub-factors, originating from the same basis and influencing the farmers' behaviour and actions. With 'risk' in relation to the farmers is meant the farmer's perception of risk; i.e. either elements or situations that are perceived to have an uncertain outcome and which might have a negative or undesirable influence on the farmer's future situation. Although it seems that 'risk aversion' is a too comprehensive concept to be entitled as a mechanism, it's influence should not be underestimated. Throughout the scenery of the previous chapters, it already gave evidence of it's presence. Furthermore, one should know that India does not administer a social security system. Farmers are highly dependent upon themselves. Therefore, with the limited resources they have at their disposal, the choice for taking a risk or not, is not really an option for most farmers in Tamil Nadu. Of the total number of farm holdings in Tamil Nadu, 89% are marginal and small farms (major part 'subsistence type'). Especially these farmers can not afford to take any risk. Making an uncertain, risky decision could lead to undesirable outcomes and eventually downfall, while especially subsistence farms are dependent on farming activities to secure their livelihood. Therefore they have to play safe and have to be on the lookout for risky situations constantly. In this paragraph, with findings of previous chapters it will be illustrated how the element of risk is embedded as a mechanism in the socio-technical rice cultivation environment of Tamil Nadu and how it influences farmers' motives for certain behaviour and actions.

Rice is the major crop being cultivated in Tamil Nadu, being both the farmers' main source for food and income. As for the reasons for cultivation of rice as a main crop, 'risk aversion' is involved in the choice for rice. Rice is traditionally being cultivated and the knowledge on cultivation is passed on from generation to generation. Accordingly, the farmers are fairly acquainted with the rice crop and therefore feel secure about having the cultivation and it's related matters under control. Farmers even entitle rice as an easy crop, relatively insusceptible to damage, and which needs little maintenance to come to acceptable yields. Furthermore, they have experienced from the past that it is possible to earn a living with the cultivation of rice, and have gained knowledge on how to do this. Switching to the cultivation of a new and totally different main crop, implies a period in which the farmer has to get acquainted with this new crop, which is normally done through practical experience. Accordingly, it will at least take some time, before the farmer masters the new crop sufficiently to earn a living with it. At least if it is possible to reach a satisfactory result at all. With switching to an alternative crop, the farmer takes the risk of an unpredictable outcome and thus an uncertain livelihood for his family. Furthermore, during the north-east monsoon season, during which heavy rainfalls occur, water damage can be the case with crops other than rice; and additionally, the Tambiraparani basin is management by the Water Resource Organisation mainly for the purpose of rice irrigation, making it harder and more risky to cultivate alternative crops. Therefore, the most familiar and safest direction is chosen by the majority of the farmers: cultivation of rice. Next to this, farmers have the opportunity to independently crop and control their own food supply. Rice is the staple food in Tamil Nadu and thus farmers will try to crop rice at least once a year, to control and secure food / rice self-sufficiency for their family. With this independency, they feel more secure concerning the provision of family food.

Throughout the year farmers have to make certain decisions, regarding the cultivation of rice. The most important decision the farmers have to make is right before starting the cultivation: they have to decide if to grow rice, yes or no. With the present problem of limited and irregular availability of water for crop irrigation, this choice brings about a risky and uncertain element: will there be enough water available for irrigation until the crop is fully completed? To reduce this risk, the farmer could decide to only cultivate part of his total area. If the farmer starts a crop, and during the crop growth period it appears there is not enough water available to complete the crop, the farmer will suffer yield reduction or total crop failure. If so, this situation is even worse than not have started a crop at all, while the purchased inputs have been wasted and issued loans can not be paid off with income from the harvested yields. On the other hand, not taking the risk of starting a crop, implies no harvest for certain and thus no income and food for livelihood for the season.

Throughout the rice season the farmer has to make likewise major and minor 'risk'-based considerations towards cultivation and related matters. However, 'risk aversion' is a subjective mechanism, while it is perceived differently by farmers, based on personal views and objectives and on the resources and options they have at their disposal. They will deal with the potential risk accordingly. In section 4.2 the attempt was made to structure the complex reality of the farmer community in Tamil Nadu into a workable set op typical farm types. By using the formulated farm types, the differences in risk perception among farmers can be somewhat explained.

On average, the commercial farm types are in the best position of dealing with certain levels of risk. They are not fully dependent on the yearly farming results, while sufficient savings or a primary occupation other than farming ensures livelihood for their families during bad years. During successful years the relatively large land areas and good irrigation facilities (mostly several sources) enables them to generate a substantial farm income. Furthermore, farm savings also enables them to purchase certain tools to avoid elements of risk to a certain extent. On the contrary, the subsistence farm types, which encompass the majority of the farmers, are very susceptible to risk elements. They are highly dependent on the yearly farming results to ensure livelihood for their families. Because of the marginal landholdings and minimal irrigation resources (mostly one source), the farmers will crop rice mainly for self-sufficient supply of rice for food. Only a small portion remains to be sold on the market. With minimal farm savings, they are dependent on the possibility of issuing a loan to purchase the inputs needed for cultivation. For additional income, the farmers are also dependent on agriculture, while they will work as an agricultural labourer on other farms. Therefore, during bad years these farmers have hardly any alternatives to earn a living. Especially the subsistence farmer types would surely try to choose the safest options that create a secure, stable and durable livelihood for their family. In the view of the subsistence farmers a durable, secure livelihood has much more value than taking the risk of reaching production or profit maximisation; a risk which commercial farmers are more likely to take. As regards the intermediary farm types, their risk perception is, as the typification already indicates, an intermediate form between commercial and subsistence farm types.

Additionally, it is observed that farmers' behaviour and actions became more influenced by the external management of various elements of the rice cultivation environment. While over a period of time problems in the agriculture sector grew to a level of threatening the state's future development (e.g. food security, poverty alleviation), farmers' freedom of action regarding cultivation and risk management has partly shifted towards external management by Government and science with enforcing certain measurements. (e.g. implementing policies; introducing technologies; distributing resources). Along with these measurements, farmers' self-control decreased and dependency on external managed conditions increased. In the perception of the farmers, the decreasing self-control and increasing dependency creates a more risky situation. Subsequently this brought about new problems and limitations for the farmers. The major development, which initiated the increasing dependency of farmers on external factors, has been the introduction of the Green Revolution. With this development the farmers' decreased self-control and increased dependency is being further illustrated.

The increasing demands for rice during the 1970s and 1980s were successfully met with the introduction of the Green Revolution's intensification principles, developed by western science. Rice yields were increased significantly, but at the same time farmer's dependency grew as well: dependency on the supply of high yielding varieties and the inextricable linked need for chemical fertilizers and pesticides to come to the promising yields. Nevertheless, at the time the Green Revolution principles were introduced, it was a relief to the problems in those days; however, possible future imperfections and problems were not being considered. Over a period of time, the Green Revolution cultivation principles have taken a prominent place in the farmers' socio-technical environment, making them indispensable to farmers for their livelihood. Currently the majority of the farmers in Tamil Nadu are cultivating rice according to the Green Revolution's principles. However, an unpleasant side issue is that all the inputs have to be purchased. As a result, nowadays most farmers are forced to issue a loan (section 4.3.3), to acquire the needed inputs. Before the Green Revolution practices set in, farmers were not dependent on purchasing sowing-seed and additional needed external inputs (chemical fertilizers, pesticides): farmers stored part of their harvest as sowing-seed input for the next season and external inputs were used a lot less intensively than they are being used nowadays; or they were not used at all. Furthermore, the Green Revolution principles are inextricably linked with intensive irrigation. Therefore, with the present problem of limited and irregular availability of water for crop irrigation another constraint comes into the picture. A majority of the farmers feel powerless in overcoming the problem of limited and irregular water availability as alternative irrigation options are already overexploited. Furthermore, the Green Revolution principles are developed from the objective of efficiency, effectiveness and profit & production maximisation; i.e. a production system based on profit maximisation and not on risk aversion. Such a system goes hand in hand with certain levels of risk, despite the earlier mentioned fact that the majority of the farmers rather prefer a durable, secure livelihood, than taking the risk of reaching production or profit maximisation. Finally, the Green Revolution's intensification principles are developed in such away, that only the combination of a set of external inputs leads to the promising yields, so hardly alternative variants are there. Therefore, the farmers have become depend on the specific combination of external inputs, created by science, to come to acceptable yields.

Except from the growing dependency on external inputs, additionally the farmers became more dependent on the administrative bodies, directing certain elements within the rice cultivation environment of Tamil Nadu. After the independency of India (1947) and with the introduction of the Green Revolution, many agricultural matters were being centralized and managed by Government departments. The number and complexity of the rules and regulations grew and became less transparent. As due to this Government interference, the farmers' freedom of action was being reduced, which is perceived by the farmers as a higher level of risk. At present, almost all the agricultural inputs are being supplied and distributed by Government departments: high yielding varieties (developed by rice research institutes of the TNAU), chemical fertilizers and pesticides are distributed at the Agricultural Extension Centres; irrigation water from the Tambiraparani Basin is regulated and distributed by the Water Resource Organisation; and loans to purchase the inputs have to be issued at (Government) banks. There are alternatives though, but each with its defect: farmers can also purchase the inputs at private distributors (at higher costs); farmers with a well as an irrigation source can somewhat control their water supply (although, ground water level is overexploited); and loans can also be issued at private loaners (at higher risk). Furthermore, the Government appointed a special department to encourage agricultural development: the Directorate of Agriculture (extension). Through extension activities, the newest agricultural technologies (modern science GR based) were/are presented to the farmer society. The technologies introduced were/are mainly developed from the earlier discussed objective of efficiency, effectiveness and profit & production maximisation; the aftermath of the Green Revolution. The effects and influences are known, as they have already been discussed above.

5.4.2 Farmer's innovativeness

Farmers' innovativeness is related to the concept of indigenous agricultural knowledge (section 2.3). In general, indigenous agricultural knowledge is gained by farmers through a process of learning. In order to reach their objectives, farmers develop their own skills for making use of their (local) environment by developing, testing and improving practices. Through such a process, indigenous innovations could be developed. In section 2.3 it was said that scientists and researchers should make use of the available indigenous agricultural knowledge, and integrate it with their scientific knowledge, to come to more suitable solutions and technologies for agricultural problems. However, during the execution of this study, such an indigenous innovation processes was not clearly present. Nevertheless, several underlying reasons for the presumable minimal presence of farmers' innovativeness in the study area could be detected.

First of all, one of the reasons for the low innovativeness of the farmers in Tamil Nadu can be ascribed to the controversial tenure system left behind by the era of British colonialism after the independency of India in 1947 (section 1.4.2). Due to this tenure system, the farmers were maximally exploited by the landlords. Therefore, a barrier was created for the farmers to develop indigenous innovations. In an article by Shariff (1987) on this topic it is argued that:

> "Economically it can be argued that the land is incapable of supporting both the cultivator and the intermediaries, and that the intermediary system discouraged initiative of the cultivator hence the improvement of land. The cultivator naturally had no interest in improvement because most of the benefits would go to the intermediary" (Shariff, 1987)

It seems that the tenure system has not benefited the innovativeness of the farmers and even has delayed the agricultural development of Tamil Nadu in general. Furthermore, the tenure system left behind a landholding structure, characterized by heavy concentration of cultivable areas in the hands of relatively large landowners, excessive fragmentation of small landholdings and a growing class of landless agricultural workers, which again did not benefit farmers' innovativeness and agricultural development in general. Although the Government has attempted to overcome this inequality by land reform measurements, the reforms have failed to reach their aims and did not succeed in their central intended purpose (section 1.4.2). At present the Government of Tamil Nadu is still engaged with the land reform problems.

For the second reason, the mechanism 'risk aversion' comes into the picture again. Innovating implies mainly a process of experimenting, testing and improving practices. While outcomes are uncertain, the innovation process is involved with a certain level of risk. As already discussed in detail in the above sections of this chapter, this influences the farmers' motives for certain behaviour and actions. The majority of the farmers will choose the safest options regarding their cultivation and therefore innovating is not being considered. Furthermore, along with the introduction of the Green Revolution in Tamil Nadu, the farmers did not feel the need to innovate anymore, while science and Government took on this task. Science takes on the experimenting, testing and improving element of the innovation process, and the Government provides the farmers with the results. However, because of the science's innovation monopoly, more general applicable technologies are being developed. Subsequently, the local conditions that create specific opportunities or limitations for farmers are cancelled out in the science's innovation process.

5.5 The relations of farmers with other actors and elements in the rice cultivation environment and their interactions

Within the social-technical rice cultivation environment of Tamil Nadu all different kinds of actors, elements and stakeholders are active, exerting influence on each other, on technologies and on the social environment as a whole. Within this complex environment farmers are important actors. Currently, they are the ones that are directly facing the effect of the present problem of limited and irregular availability of water for crop irrigation, and thus they are the ones that will have to implement possible solutions, technologies and policies developed by scientists and politicians to the present problems in the agricultural sector of Tamil Nadu. In consequence, in order to develop suitable solutions, it should be well understood how farmers are related towards other actors and elements of the rice cultivation environment and how they interact with each other. In previous chapters certain relations and interactions already came up during other topics discussed. However, the total picture of the main actors and elements together has not yet been displayed and discussed. To illustrate the relations and interactions between the different actors and elements of the rice cultivation environment in Tamil Nadu, a graphical representation is drawn up and displayed in figure 5.1.

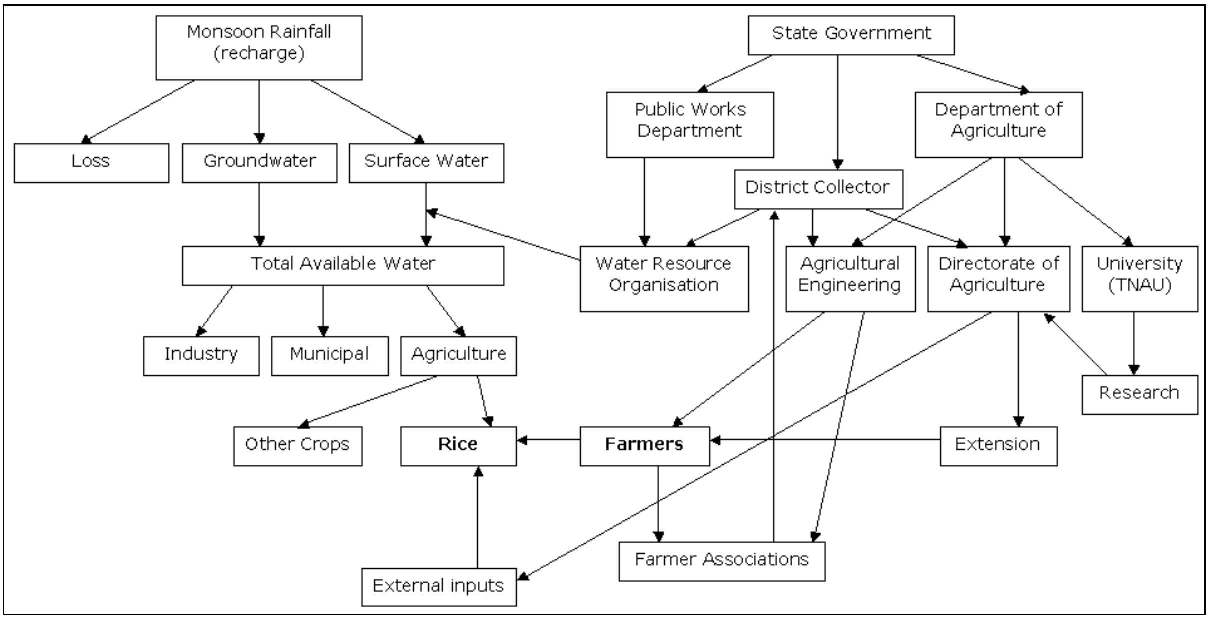

Figure 5.1: Interactions of the main actors and elements of the rice cultivation environment in Tamil Nadu

With drawing up the schedule of figure 5.1 the actors and elements displayed have been limited to the main and most influencing ones and the ones that have been taken into account by this study. The left part of the schedule displays the water supply and distribution to the farmers; the right part is involved with the Government interference in the rice cultivation environment in Tamil Nadu. Furthermore, from this schedule the direct and indirect relations and interactions become clearly visible. In this section some of the most important and remarkable relations will be discussed. In particular the contradictions and imperfections in the relations and interactions between the different actors and elements will be emphasised.

5.5.1 Farmers vs. Government

At present, the main agricultural issue for both farmers and Government is the problem of limited water availability for crop irrigation. Because Government and farmers are both experiencing the difficulties regarding the present water problem, but from different perspectives, participation between Government and farmers is indispensable for resolving the present problems in the agricultural sector. However, it seems that especially this participation between farmers and Government leaves much to be desired.

If we take a look at the schedule in figure 5.1, we can see that the main Government body concerned with the distribution of surface water for irrigation, the Water Resource Organisation (WRO), has no direct connection with the farmers. As a result, deficiencies may occur (section 1.3.2; Brewer *et al.*, 1994). In fact, presently communication with the farmers mostly takes place through the monthly held 'Farmers Welfare Meeting' at the District Collector's office. With proper participation between farmers and the WRO, deficiencies can be prevented, making the water distribution more efficient. As a matter of fact, the Government already recognises the importance of the cooperation of farmers with the WRO and proposed the implementation of an Irrigation Assessment and Action Programme (section 4.4.3).

In case of the other two Government departments of importance to the farmers, Agricultural Engineering and the Directorate of Agriculture (extension), direct connections with the farmers exist, but mostly in the form of a one-sided communication instead of participation. The farmers are being provided with new technologies, information and advice, but are not being incorporated in the development process. Therefore also in this case still deficiencies may occur. Furthermore, the extension department of the Directorate of Agriculture is only connected to a part of the total farmer society, while not all farmers can be reached (remote areas, unschooled farmers, progressive farm system; section 4.4.1). The university normally has no direct connection with the farmers, but indirectly through the Directorate of Agriculture, by means of providing them with the latest technologies emanating from the research programmes.

At present the low collaboration between farmers and Government is causing different perceptions towards the same initial problem of water. On the one hand the Government is dealing with the problem of limited water from the perception that Tamil Nadu's future self-sufficiency and security of food and poverty alleviation are being threatened. Next to this, they also have to take account of the ongoing developments and growing water demand of the industrial and service sectors. Farmers, on the other hand, are not engaged with problems at such a scale. They are more concerned with their personal local problems for own survival first, than they are with the same problems at a higher level. They are merely facing the everyday matter of ensuring livelihood for their families under the existing local conditions. Nevertheless, farmers are aware of the growing water problem: they observe the consequences of the reducing water availability by means of yield reduction, crop failure, or forced changes in their cropping pattern. However, the majority is not aware of the large scaled future problems, although they are part of it. With insufficient participation between Government and farmers during a solution building processes, this could bring about discrepancy during the implementation phase. Therefore farmers and Government should be known with each other's objectives and problems in order to come to successful solution implementation; i.e. solutions should be developed through a participatory process.

A good opportunity to realise a better participation between farmers and Government, would be through the already existing farmer associations. These associations are formed spontaneously by the farmers themselves for regional water management and for the purpose of lobbying at Government departments (section 4.3.6). Although, the communication between farmer associations and interrelated Government departments is mostly indirect and one-sided (figure 5.1), and not of participatory nature. However, using this spontaneously formed communication networks of indigenous farmer associations, would surely be a good option to improve the participation between farmers and Government.

5.5.2 Government vs. Government

The communication and cooperation between Government departments seems to be far from optimal. It appears that the different departments are largely focusing on the topics within their own field and responsibilities, and hardly involve in the activities of the other departments, although those are working on closely related topics (section 4.4.4). Every Government department formulates and implements major and minor development schemes within their responsible field. The large number and variety of the development schemes is a complex assemblage. Due to the lacking communication and cooperation between Government departments, the overlap and inconsistency between schemes of different departments is highly assumable. Therefore, discrepancies between the implementation of policies of the different departments may arise.

Normally, the most intensive contact between the different departments is during the monthly held 'Farmers Welfare Meeting' at the District Collector's office, with farmer associations. Within the Agriculture Department, which Agricultural Engineering and

Directorate of Agriculture are part of, there are held meetings now and then between the sub departments.

Furthermore, from a study of Brewer *et al.* (1994) it seems that deficiencies have occurred in the Tambiraparani water distribution rules, which are the responsibility of the Water Resource Organisation. He argues that because of the (continuing) changes in water use in the Tambiraparani system, the original water distribution rules for the system do not longer match with the changed water uses, and discrepancies have occurred (section 1.3.2). With formulation of renewed system distribution rules, with the involvement of users, several important discrepancies can be put aside, clearing the way for more efficient and equitable distribution of the system's water supply.

One of the reasons for the present inefficient Government machinery, could be it's organisation. The Governmental system in Tamil Nadu is a complex system. It is hard to fathom the organisation and functioning of the total Governmental system, but it is clear that it has a formal, top-down pyramid like vertical structure of organisation. Such an organisation structure can work very efficient and effective, if all bodies, officials and employees are functioning and communicating as they are supposed to. The transparency is low, the length of communication lines is long, and the sensitivity for stagnations and corruption is high. It seems that especially in the lower layers of the Government 'pyramid' system variations in efficiency and quality arise (section 4.4.5) and communication of the lower levels with higher levels proceeds wearisome. Unfortunately, this is actually the level of the direct communication between Government and farmers. In India deficient organisation and past corruption has had its influence on the function of the present Government. The improvement of the organisation structure and the struggle against corruption are continuing, but the after-effect of the past imperfections are still visible.

Fine tuning of the mutual communication between Governmental departments within the complicated structured machinery of Government is of importance for efficient, effective and successful development and implementation of policies. Presently, it seems that still discrepancy exists.

5.6 Expectations on farmers' implementation of the SRI as a solution to the current problem of limited and irregular availability of water for crop irrigation

The System of Rice Intensification (SRI) seems to be a promising and suitable option to overcome the problem of limited water availability for the cultivation of rice in Tamil Nadu. Additionally, it could mean a breakthrough of the present stagnation in the agricultural sector, while with eliminating the water problem an important step forward in the direction of agricultural development can be taken. However, one should not be dazzled by the promising prospects, while the process towards successful and widespread adoption is far from easy. Besides, there is even no guarantee that the SRI is *the* durable solution to the present problems in the agricultural sector, while future outcomes can hardly be foretold. Therefore, with the knowledge and information gained from this study so far, several assertions are made and expectations are formulated regarding the SRI as a possible solution to the current problem of limited and irregular availability of water for crop irrigation.

5.6.1 Local technologies as global solutions

The System of Rice Intensification is a cultivation system that was originated in Madagascar. In Madagascar it was further developed especially for resource poor farmers to increase rice production, as an alternative to the slash-and-burn cultivation practiced. Because the SRI includes a water-saving element, the system became of interest for Tamil Nadu as a possible and promising option to overcome the water problem for the cultivation of rice in the agricultural sector. Since the introduction of the SRI in Tamil Nadu, the system is being further developed according to local conditions and environments.

However, in Tamil Nadu the SRI was introduced in a (social-technical) environment being different from the farming environment of Madagascar in which it was originally developed. If this farming environment is compared to the one in Tamil Nadu, the main reason for the way the SRI was developed in Madagascar seems absent in Tamil Nadu: resource poor farmers and the absence of Green Revolution inputs. If one thing is clearly visible and abound in Tamil Nadu, it is the influence of the Green Revolution. The SRI is merely of interest to Tamil Nadu because of one of its several cultivation practices, the water-saving practice. The other practices are of lesser interest but partly necessarily to come to the desirable results. Therefore the SRI in Tamil Nadu is practiced with the main SRI practices (section 1.4.4), as developed in Madagascar, combined with the all ready available and broadly used Green Revolution practices.

Nevertheless, the question remains if a local developed technology can be transferred to other parts of the world. Although scientists and researchers remain divided about the answer to this question (section 1.4.4), the field experiments carried out until now in Tamil Nadu have had some promising experimental results (Thiyagarajan and Selvaraju, 2001; Thiyagarajan *et al.*, 2002; Thiyagarajan *et al.*, 2003; Thiyagarajan *et al.*, 2005). Whether or not the adjustments of the SRI in Tamil Nadu can be considered as successful implementation of the SRI is a moot issue. The most important lesson to be drawn from the Tamil Nadu experiences is that a new and unconventional approach to innovation, which builds on existing cultivation practices, can lead to successful improvements. The supporters of the SRI should continue with the experimental research work on SRI in Tamil Nadu, and in other parts of the world, in order to scientifically clarify the potency of farm-based methods as a global applicable approach.

Next to the technical aspects of the SRI, also the factors determining successful introduction and adoption of the SRI by Tamil Nadu's farmer society should be analysed. This is done in the next two sections.

5.6.2 Diffusion of the SRI

The successful adoption of an innovation among the members of a social system, is preceded by a successful diffusion process. Diffusion is defined by Rogers as the process in which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 2003). With this definition the main elements of an diffusion process are being displayed: 1) the innovation; 2) the communication channels; 3) time and 4) the social system. In order to test the successfulness of the SRI as a solution to the water problem, the system is analysed in accordance to the 4 elements by Rogers.

According to Rogers, there are five characteristics of an innovation that determine its adoption rate (section 2.2.):

1) Relative advantage:

The relative advantage of the SRI is clear: higher yields with less water. In the case of Tamil Nadu, both are in to the advantage of the farmers, making it interesting for farmers to adopt this system.

2) Compatibility:

The SRI is developed for the traditional and main food crop rice, which is in favour of the farms. However, the SRI system was originally developed for resource poor farmers in Madagascar, although farmers in Tamil Nadu have better access to external inputs.

3) Complexity:

The SRI is more complicated and diverge than the conventional system and requires specific skills. This will cause initial problems, which is not in favour of the farmers (risk, uncertainty). Several farmers may find this new system too risky.

4) Triability:

Promotion of the SRI by field trials among the farmers by university and extension service is a good option. From the surveys it seemed that after a field trial was conducted, several farmers would experiment with SRI themselves the next season. After they practiced the SRI themselves, they were also more convinced of the promising results. However it should be noted, that only part of the farmers are reached by university or extension service (not reached: remote area farmers, unschooled farmers, non-progressive farmer).

5) *Observability:*

The surveys show that farmers observe each other, exchange ideas and even discuss about the cultivation practices. This will speed up the diffusion of the SRI.

The main channels trough which the SRI is being communicated is the Directorate of Agriculture (extension) and farmer-to-farmer. Farmer-to-farmer has a high diffusion effect, while the innovation is communicated within an homophily group (similar belief, education, socio-economic status, etc.) Actually, farmer-to-farmer is also the principal of the progressive farmer system of the extension department. Furthermore, with a deliberately introduced innovation (extension), which would be the case with SRI, it is important that this is done by homophilous persons. In case of the extension department this reached through an AAO, which stands close to the level of the farmers.

Innovators, the first users of an innovation, are important for the diffusion process. The adoption of a new innovation goes together with a certain extent of risk. Innovators are farmers that dear to take that risk. From section 5.4.1 we concluded that aversion of risk is a mechanism controlling farmers' behaviour and actions, and that the majority of the farmers are unable to take such a risk. Therefore the group of innovators in Tamil Nadu will be small, consisting mostly of commercial and intermediary farm types (section 4.2). Individually the farmers make their decision for adoption in 5 steps: 1) knowledge, 2) persuasion, 3) decision, 4) implementation, 5) conformation (section 2.2). This decision process will be different for each farm. Most probably, the commercial farm types will adopt the SRI first (innovators), followed by the intermediary types and subsistence types.

Because the diffusion of an innovation occurs within, and changes, a social system, the characteristics of the social environment (farmer society) are important factors in the diffusion path leading to adoption. This will be analysed in the next section in the case of Tamil Nadu.

5.6.3 Expectations on farmers' implementation of the SRI

The System of Rice Intensification was taken cognisance of in Tamil Nadu only relative recently (around 2000). After the promising results of the first field experiments executed, Dr. T.M. Thiyagarajan (TNAU) was able to get permission and fundings to realise the first State Plan Scheme on SRI, consisting of on-farm trials in the two major rice-growing regions of the state. From thereon the process of promoting and popularising the SRI set in. Nowadays the SRI is being popularised by the Directorate of Agriculture (extension) and Government State Plan Schemes in several regions of the state. The farm surveys for this study were conducted in the area (Tambiraparani tract) were just the State Plan Scheme on-farm trials were finished. Using the farmers in this area as a main source for the farm surveys, provided a group of farmers with first experience in the SRI.

Because the SRI only recently is being promoted among the farmers in Tamil Nadu, results on farmers' adoption of the SRI are not available. However, along the diffusion and adoption path, it would be useful, when obstructions could be predict. With this study an attempt is made to formulate bottlenecks, opportunities and subsequent expectations regarding the farmers' SRI adoption behaviour. In this final part, the findings of this study should come together, to formulate several expectations on farmers' implementation of the SRI as a solution to the current problem of limited and irregular availability of water for crop irrigation.

We should keep in mind that the SRI was originally introduced in Tamil Nadu, as a possible solution to the present problem of limited and irregular availability of water for crop irrigation in the agricultural sector. So we should try to formulate expectations on 1) the farmers adoption of the SRI and on 2) the usefulness of the SRI as a solution to the present water problem in the state.

Expectations 1 - Farmers' adoption of SRI

The farmers that were part of the State Plan Scheme on SRI, were surprised and positive about the SRI and its results after the on-farm trials. They were amazed with the fact that higher yields could be reached with less water. However, still relatively few farmers of the State Plan Scheme group have adopted the SRI. Only several farmers pratice SRI on a small part of their area, just for a experimentation. Most farmers tell that they are not familiar enough with the SRI technique to independently (without help from the university, like with the on-farm trials) practice the system. Compared to the conventional rice techniques, the SRI techniques are perceived as difficult. Farmers trust more on their traditional techniques, with which they have been familiar for many years and from which they know what they can expect; with the SRI, farmers are anxious about implementing the practices wrongly, with the risk of crop failure. We see here that the farmer's decision is influenced by the 'risk aversion' mechanism (section 5.4.1). Subsequently we are able to define what kind of farm types could be in the position of adoption of the SRI, with respect to the above mentioned observation. The farm type that would most likely be the first to adopt the SRI (innovator), is the commercial farm type. The commercial farm types are in the best position of dealing with certain levels of risk. They are the ones that could afford to take a risk with the adoption of the SRI. The following early adopters are represented by the intermediary types, basing their adoption decision on the first results of the innovators. If the SRI seems to be effective and successful, the majority of the other adopters, the subsistence farm types, will follow.

The farm surveys with farms that were no part of the State Plan Scheme on SRI, indicated that SRI was hardly known about by them. Only some of them had heard about the SRI, but had no idea about its practices or advantages. They would also not take the trouble to inquire into the SRI.

Farmers indicated which points of the SRI, were problematic to them. The most important ones are formulate in section 4.3.5. If we look at the difficulties formulated in that section, it can be concluded that again the 'risk aversion' mechanism is applicable.

From a study in Sri Lanka on the prospects for adopting the System of Rice Intensification (Namara *et al.*, 2003), surprising similarities with the Tamil Nadu situation were found. It should be noticed though, that the results are based on the SRI practiced with manual weeding (which implies a much higher labour need, which thus was also concluded as one of the bottlenecks with SRI in Sri Lanka). From the conclusions that are made, again the 'risk aversion' mechanism can be extracted, based on likewise reasons as found with this study. Furthermore, the characteristics of farms regarding the adoption of SRI correspond in the same way with the farm types formulated with this study.

Additionally, the first signs of social rearrangement in the farmer society, due to the adoption of SRI, also were observed with this study. Female farmer labourers told that due to the SRI technique the male workers have taken over the weeding operations, traditionally done by females. With the SRI, the weeding is done with a rotary or cono weeder. Because this is perceived as a heavy physical job, it is done by male workers.

Expectations 2 – SRI as the water problem's solution

The SRI could only be of significant importance to the water problem in Tamil Nadu with widespread adoption among the farmer society. With sporadic adoption of the SRI there is only little water saving at system or basin level and therefore it's contribution would be of minor importance.

The irrigation practices of the SRI, as compared of those of the conventional system, differ from each other. The Tambiraparani irrigation system is managed for the purpose of distributing irrigation water for conventional rice cultivation. Practicing SRI in an area were the irrigation is adjusted to the conventional rice cultivation system causes problems with executing the irrigation practices. This may influence the potential production, as well as the water use efficiency. Therefore, to both reach the goal of higher production and more efficient water use, all farmers of a region should adopt the

SRI technique and Water Resource Organisation has to be willing to change the distribution rules accordingly. Although, farmers that have a well as an irrigation source at their disposal, will experience less difficulties with the irrigation of an SRI crop, while the irrigation practice can be better controlled. However, only if this source delivers enough water, which is mostly not the case (overexploitation groundwater).

It is discovered that the water distribution rules of the Tambiraparani river basin show deficiencies and are not in accordance with farmers water demands. Furthermore, the water distribution structures are old-fashioned, due to which water losses are significant. Therefore, the regulation and organisation of the Tambiraparani river basin should undergo a thorough reorganization as well.

5.7 Final Conclusion

The System of Rice Intensification proves to be a promising option to reduce the problem of limited and irregular water availability for crop irrigation in the agricultural sector of Tamil Nadu. Although, it seems that the SRI is not *the* single solution. With looking beyond the technical aspects of the water problem and including the just as important social aspects, many more additional elements, actors and factors were uncovered. The System of Rice Intensification is just one of the many alterations that have to be accomplished within the rice cultivation environment of Tamil Nadu, to solve the present water problems. Successful and widespread implementation will depend upon a complete change of the whole social-technical environment, comprehending all elements, actors and factors concerned. Therefore it is concluded that the introduction of a new technology (such as the SRI) in a social-technical environment (such as Tamil Nadu) will provoke imbalance, and thus a new socio-technical equilibrium has to be established before problems can be successfully solved.

Concluding and rounding off, the main statements of this study are summarized:

1) A stable, secure and developing agricultural sector is essential for Tamil Nadu's future development.
2) Technology is socially constructed. Therefore the focus should be on the broader social-technical environment to come to suitable and durable solutions.
3) With interdisciplinary and participatory research methods, inadequacy between theory and practice of technologies can be overcome, difficulties or incompetence at the implementation phase can be anticipated or prevented, and the need for implementing a new technology at all can be detected.
4) It seems that 'risk' is embedded in many aspects of the rice cultivation in Tamil Nadu, and that 'risk aversion' plays a major role in the farmers' decision process.

5) ‘Risk aversion’ is a subjective mechanism.
6) The commercial farm types are in the best position of dealing with certain levels of risk; The subsistence farm types, which encompass the majority of the farms, cannot afford to take any risk and are very susceptible to risk elements. Special attention should be given to these types of farms.
7) From the farmers’ point of view a durable and secure livelihood has much more value than taking the risk of reaching production or profit maximisation.
8) Farmers’ behaviour and actions have become more influenced by the external management of various elements of the rice cultivation environment.
9) Participation between Government and farmers is indispensable for resolving the present problems in the agricultural sector.
10) Insufficient participation between Government and farmers during a solution building process could bring about discrepancy during the implementation phase.
11) A good opportunity to realise a better participation between farmers and Government, would be through the already existing farmer associations.
12) Fine tuning of the mutual communication between Government departments within the complicated structured machinery of Government is of importance for efficient, effective and successful development and implementation of policies.
13) Within the SRI diffusion process commercial farm types are innovators, intermediary farm types are early adopters, and subsistence farm types are the mass adopters.
14) Farmers SRI adoption decision is influenced by the ‘risk aversion’ mechanism.
15) The SRI could only be of significant importance in solving the water problem in Tamil Nadu with widespread adoption among the farmer society.

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Appendix

Appendix A: Tables

Table A.1: Land use in area in Tamil Nadu (10^5 ha)
(State Planning Commission, 2004 & Department of Economics and Statistics, 2004)

Classification	Decade					Year		
	1950s	1960s	1970s	1980s	1990s	’01-’02	’02-’03	’03-’04
Forest	18.14	19.06	20.05	20.76	21.44	21.32	21.32	21.22
Barren / unculturable	9.73	8.85	7.05	5.57	4.95	4.77	4.78	5.09
Non agricultural use	12.70	13.57	16.00	17.95	19.07	19.98	20.12	21.13
Culturable waste	8.70	6.60	4.15	3.08	3.25	3.87	3.89	3.79
Pastures & grazing land	3.75	3.34	1.98	1.45	1.25	1.18	1.18	1.13
Tree crops & groves	2.49	2.64	2.15	1.82	2.25	2.71	2.78	2.83
Fallow	17.65	15.81	17.33	23.21	21.50	24.35	29.94	28.17
Net area sown	56.38	60.26	61.35	56.22	56.32	51.73	45.90	46.89
Total	129.54	130.13	130.06	130.06	130.03	129.91	129.91	130.25
Area sown more than once	10.31	11.74	13.21	10.55	10.97	10.54	6.00	6.27

Table A.2: Rice in Tamil Nadu
(State Planning Commission, 2004; Department of Economics, 2004; Directorate of Rice Development, 2005)

Classification	Decade					Year		
	1950s	1960s	1970s	1980s	1990s	’01-’02	’02-’03	’03-’04
Total cultivated area (10^5 ha)	66.69	72.00	74.56	66.77	67.29	62.27	51.90	53.16
Area with rice (10^5 ha)	20.89	25.70	26.41	21.73	21.52	20.60	15.17	13.97
Percentage of total area (%)	31.32	35.69	35.42	32.54	31.98	33.08	29.23	26.28
Productivity (10^2 kg/ha)	-	-	-	23.97	30.96	31.96	23.59	23.08

Table A.3: Irrigated area in Tamil Nadu (10^5 ha)
(State Planning Commission, 2004 & Department of Economics, 2004)

Source	Decade					Year		
	1950s	1960s	1970s	1980s	1990s	’01-’02	’02-’03	’03-’04
Canal	7.92	8.83	8.94	8.23	8.23	8.01	6.14	4.49
Tank	7.76	9.12	8.49	6.16	6.21	5.37	4.22	3.85
Well	4.97	6.45	9.18	10.38	13.14	14.49	12.63	12.99
Others	0.46	0.39	0.35	0.19	0.17	0.14	0.11	0.15
Total	21.11	24.79	26.96	24.96	27.75	28.01	23.10	21.48
Irrigated more than once	6.19	7.87	8.26	6.19	6.41	6.11	3.12	3.31

Table A.4: Land holdings in Tamil Nadu (State Planning Commission, 2004 & Agricultural Census ’95/’96)

Classification	Number (10^5)				Area (10^5 ha)			
	’70-‘71	’80-‘81	’90-’91	’95-‘96	’70-‘71	’80-‘81	’90-’91	’95-‘96
Marginal (< 1 ha)	31.25	50.15	58.48	60.40	13.21	19.07	21.18	22.91
Small (1-2 ha)	11.09	12.09	12.75	13.05	15.78	17.10	17.94	18.32
Semi-medium (2-4) ha)	6.96	6.58	6.18	6.33	19.14	18.22	16.87	17.29
Medium (4-10 ha)	3.25	2.69	2.27	2.27	18.93	15.55	13.01	12.72
Large (> 10 ha)	0.59	0.40	0.31	0.34	10.03	7.14	5.74	7.37
Total	53.14	71.91	79.99	82.39	77.09	77.08	74.74	78.61

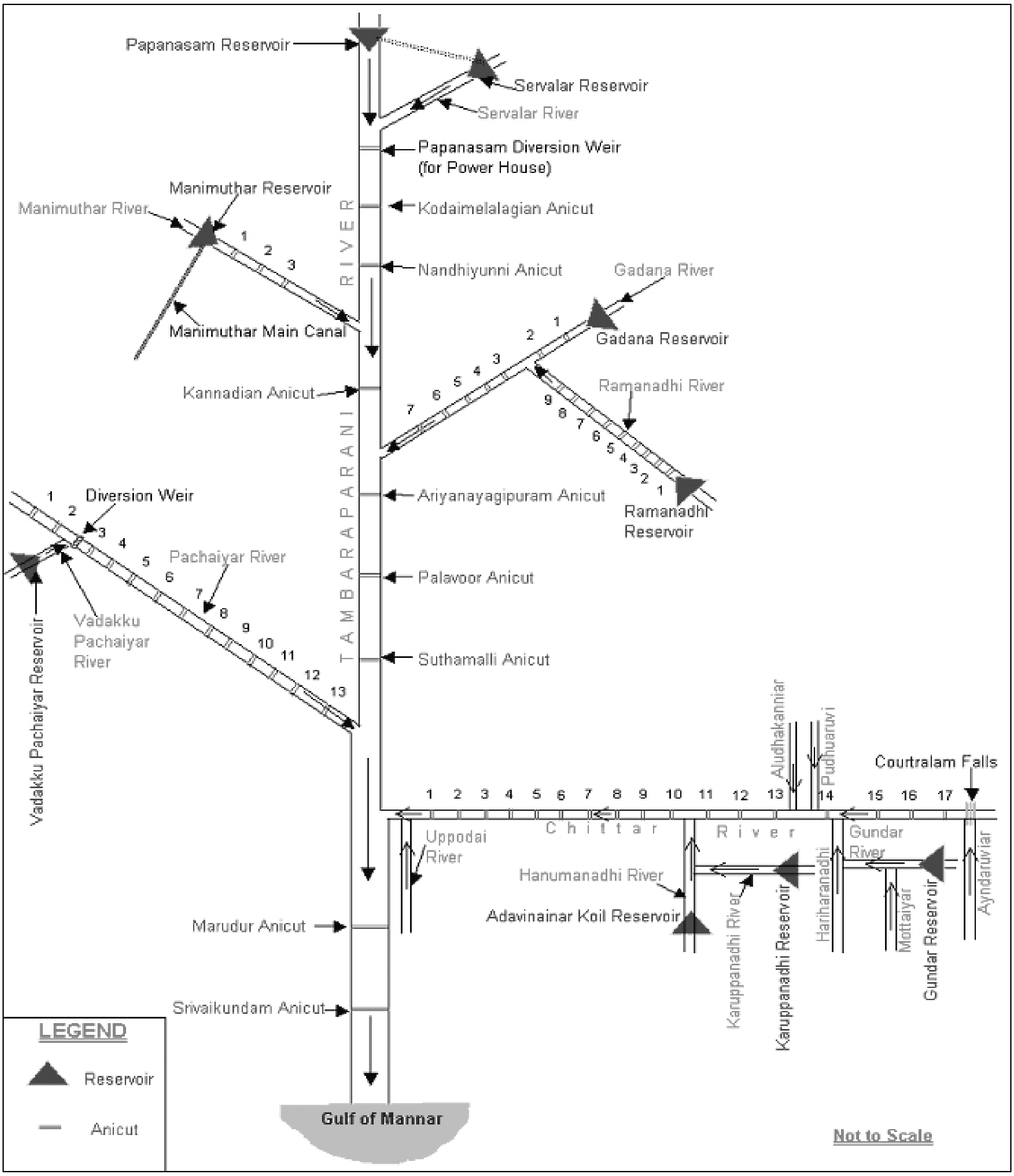
Table A.5: Rainfall in Tamil Nadu (mm) (State Planning Commission, 2004)

Year	South - West Monsoon	North – East Monsoon	Winter Season	Summer Season	Total
1970-71	318.0	420.2	27.4	152.6	918.2
1971-72	323.3	488.5	4.6	153.2	969.6
1972-73	303.9	607.7	0.2	80.5	992.3
1973-74	332.7	406.7	9.7	93.1	842.2
1974-75	326.2	177.5	10.5	133.2	647.4
1975-76	419.7	339.8	1.4	96.3	857.2
1976-77	314.7	440.4	24.7	162.1	941.9
1977-78	332.7	682.4	11.7	96.9	1123.7
1978-79	261.2	582.2	43.6	62.8	949.8
1979-80	361.1	604.6	0.2	125.4	1091.3
1980-81	196.4	337.0	10.5	125.4	669.3
1981-82	406.1	449.0	0.2	97.4	952.7

1982-83	216.7	352.0	0.2	93.7	662.6
1983-84	398.8	483.7	169.7	170.3	1222.5
1984-85	330.7	300.2	93.6	66.9	791.4
1985-86	381.9	376.7	95.8	96.7	951.1
1986-87	271.6	330.6	8.5	90.2	700.9
1987-88	271.3	525.4	3.7	182.4	982.8
1988-89	376.4	217.7	2.0	112.7	708.8
1989-90	348.8	340.7	90.2	136.7	916.4
1990-91	239.3	372.6	30.3	72.3	714.5
1991-92	331.8	484.9	4.1	78.1	898.9
1992-93	316.2	477.0	5.6	63.2	862.0
1993-94	305.2	709.9	35.5	121.3	1171.9
1994-95	220.3	479.0	27.2	203.3	929.8
1995-96	347.5	248.3	10.5	115.2	721.5
1996-97	454.8	541.1	13.0	112.3	1121.2
1997-98	286.0	782.3	5.5	78.4	1152.2
1998-99	340.1	602.4	21.5	116.4	1080.4
1999-00	199.9	499.5	119.5	77.9	896.8

Appendix B: Tambiraparani River – Flow Diagram & components

<u>Source:</u> Water Resource Organisation (2004)



Anicut	Channel	Channel length (km)	Tanks (no.)	Command area (ha) Direct	Indirect[a]	Total
Kodaimelalagian	South Kodaimelalagian	8.64	-	357	-	357
	North Kodaimelalagian	18.51	20	532	393	925
Nadhiyunni	Nadhiyunni	11.55	-	1,053	-	1,053
Kannadian	Kannadian	33.95	16	4,182	876	5,058
Ariyanayakipuram	Kodagan	29.04	17	1,295	1,133	2,428
Palavoor	Palayam	42.46	59	1,862	1,983	3,845
Suthamalli	Tirunelveli	29.14	23	1,022	1,572	2,594
Marudur	Marudur Melakkal	19.84	16	1,843	3,330	5,173
	Marudur Keelakkal	17.92	15	1,202	1,952	3,154
Srivaikundam	South Main	33.87	15	1,090	4,076	5,166
	North Main	36.32	6	1,331	3,850	5,181
Total			187	15,769	19,165	34,934

[a]From tanks fed by channels.

Appendix C: Typology Questionnaire

District	**:**	**Block**	**:**
Division	**:**	**Village**	**:**

1. ***Farmer Details***

Name :
Age :
Address :

2. ***Family Size***

No.	Family Member	Education Qualification	Occupation Major	Occupation Secondary
1				
2				
3				
4				
5				
6				

3. ***Family Farm Labour Availability***

No. Male: **No. Female:**

Remarks:

4. ***Farm Size (acres)***

Kind of Area	Irrigated		Rain fed	Total Area
	Surface water	Ground water		
Area owned				
Area Leased in				
Area Leased out				

Income leasing out :
Costs leasing in :

5. ***Source of Irrigation***

☐ **Canal** ☐ **Well** ☐ **Tank**

If well, how many:
Water availability (months):

Water availability enough: ☐ **Yes** ☐ **No**

Details on Source of Irrigation:

6. ***Crops Cultivated***

No.	Crop	Area (acres)
1.		
2.		
3.		
4.		
5.		
6.		

7. ***Cropping Pattern***

1.
2.
3.
4.

8. Homestead

☐ **Inside the farm** ☐ **Outside the farm (village)**

9. Other Enterprises

Name	Number	Young ones
Bullock		
Dairy		
Sheep		
Goat		
Chicken		
Mushroom		
Sericulture		
Biogas		

10. Income

Component	Percentage income (%)
Cropping	
Other Enterprises	
Other Sources	

11. Use of Inputs in Farming

Inputs	Level					
	Low		Medium		High	
Inorganic Fertilizer	N		N		N	
	P		P		P	
	K		K		K	
Organic F.						
Pesticides						

(Low: below prescription University; Medium: according to prescription University; High: above prescription University)

High Yielding Varieties: ☐ **Yes** ☐ **No**

12. Machineries

Machinery		
Owned	Hired	Used for

13. Assets Owned

☐ **House** ☐ **Household Electronic goods**

☐ **Car** ☐ **...**

☐ **Motor Bike** ☐ **...**

☐ **Bicycle** ☐ **...**

14. Sketch of the Farm (include plot size)

15. Other Remarks or Specific Information

Appendix D. Technography Questionnaire

1. What are the farmers (personal) interests (with rice production)?
2. What are the farmers (personal) goals they want to reach (with rice production)?
3. In what way do the farmers try to reach those interests and goals?
4. Is the rice production for the farmers of importance for their livelihood?
   What will they do and in what way and if there is not enough water available and the harvest will fail?
5. What kind of tactics and techniques do the farmers use to try to deal with the problem of insufficient and irregular availability of water?
6. How did they develop / find out about these techniques and tactics?
7. What kind of problems did the farmers had to cope with in the past (what were problems in the past before the water problem, or problems next to the water problem) and how did they overcome those (solutions, practices, techniques)? what kind of innovations developed?
8. How did they develop / find out about those practices and techniques?
9. In what ways do farmers work together and why?
10. What kind of collective activities do the farmers practice and why?
11. Why are farmers still practicing a conventional rice production system, if there are better systems available?
12. Green Revolution influences?
    Did the farmers take over any practices of the Green Revolution to increase the rice production?
    Which ones (artificial / chemical fertilisers, high yielding varieties, chemical pesticides) and why?
    Are they still happy about those practices? Why or why not?
    What kind of rice variety does the farmer uses and why? (for example reasons can be: high yielding, drought resistance, short / long duration / taste / marketing)
13. In what extent are the farmers well known with the SRI practices?
14. Which type of system (conventional flooded or SRI) do they prefer and why?
15. Are the farmers using the SRI practices as they are prescribed to them? If not, why not?
16. Do farmers get support from the Government in solving their problems (with water shortage) like in financial, educational or information support?
17. If there is Governmental support, do the farmers like the way the Government supports them?
18. In what way do the farmers have to rely on Governmental policies or policies of irrigation authorities for the availability of water?
19. What do farmers personally think could or would be a solution to the water shortage problem?
20. What do the farmers think of the Government policies?
21. What kind of connection with the university / Government officers / research institute do the farmers have?
22. Any awareness about the water crisis in the future?
23. Are they aware of and caring about the environment (pollution, depleting ground water)?
24. Other remarks / notes …

Appendix E: Typology data sheet

* Education level	
1 =	0-8 stnd
2 =	9-12 stnd.
3 =	college

** Major occupation farming?	
0 =	No
1 =	Yes

*** Irrigation source		Land holding + irrigation source	
C =	Canal	0 =	No
W =	Well	1 =	Yes
T =	Tank		
RF =	Rainfed		
RFT =	Rainfed T		

**** Farm wealth	
1 =	Subsistance
2 =	Average
3 =	Wealthy

Farm	Head of Farm: age (yr)	Head of Farm: education level (*)	Head of Farm: major occupation farming ? (**)	Household Members: total persons (nr.)	Household Members: average education level (*)	Household Members: working fulltime on the farm (nr.)	Household Members: working parttime on the farm (nr.)	Household Members: not working on the farm (nr.)	Permanent Labour (nr.)	Landholding + Irrigation Source (acre) (***): total area Acre	total area Ha	leased in yes / no	leased in area (acre / farm)	leased out yes / no	leased out area (acre / farm)	C/T yes / no	C/T area (acre / farm)
1	74	3	0	4	2,8	0	1	3	2	12,0	4,8	0	0,0	0	0,0	0	0,0
2	38	1	1	4	1,0	0	2	2	0	1,7	0,7	0	0,0	0	0,0	1	1,7
3	65	2	1	5	1,8	0	1	4	0	7,0	2,8	0	0,0	0	0,0	1	7,0
4	48	2	1	5	1,6	1	4	0	0	2,0	0,8	0	0,0	0	0,0	1	2,0
5	58	1	0	4	1,0	0	3	1	0	0,4	0,1	0	0,0	0	0,0	1	0,4
6	65	3	1	14	2,5	2	5	7	0	47,0	18,8	1	10,0	0	0,0	1	40,0
7	35	2	1	6	1,5	1	1	4	0	3,5	1,4	0	0,0	0	0,0	1	3,5
8	32	2	0	11	2,5	0	1	10	4	23,0	9,2	0	0,0	0	0,0	1	22,0
9	33	1	1	2	1,0	0	2	0	0	3,5	1,4	1	1,5	0	0,0	1	3,5
10	54	2	1	6	2,2	2	0	4	2	34,0	13,6	0	0,0	0	0,0	1	9,0
11	65	1	1	2	1,0	2	0	0	0	3,0	1,2	1	0,6	0	0,0	1	0,6
12	66	1	1	5	1,4	1	0	4	0	5,0	2,0	0	0,0	0	0,0	1	1,0
13	53	1	1	5	2,0	1	2	2	1	15,0	6,0	0	0,0	1	6,5	0	0,0
14	51	1	0	5	1,6	3	1	1	0	15,0	6,0	0	0,0	0	0,0	0	0,0
15	36	3	0	5	2,8	0	1	4	2	30,0	12,0	0	0,0	0	0,0	1	25,0
16	30	2	1	6	2,5	3	0	3	2	10,0	4,0	1	3,0	1	3,0	1	10,0
17	58	3	1	5	2,4	1	2	2	2	15,0	6,0	0	0,0	0	0,0	1	6,0
18	26	3	1	7	1,8	0	1	6	2	8,0	3,2	1	1,0	0	0,0	1	8,0
19	63	2	1	12	2,1	6	0	6	0	15,0	6,0	0	0,0	0	0,0	0	0,0
20	52	1	1	11	2,0	6	0	5	0	17,0	6,8	0	0,0	0	0,0	1	8,0
21	37	3	1	11	2,7	3	0	8	0	10,0	4,0	0	0,0	0	0,0	1	9,0
22	50	1	1	4	1,0	0	2	2	0	1,0	0,4	0	0,0	0	0,0	1	1,0
23	67	1	1	2	1,0	1	0	1	1	11,0	4,4	1	1,0	0	0,0	1	8,0
24	41	1	1	4	1,8	2	0	2	0	4,5	1,8	0	0,0	0	0,0	0	0,0
25	37	2	0	9	1,7	1	2	6	0	0,8	0,3	0	0,0	0	0,0	1	0.8
26	54	1	1	6	1,7	1	2	3	0	2,0	0,8	0	0,0	0	0,0	1	2,0
27	55	1	1	6	1,0	1	4	1	0	5,0	2,0	0	0,0	0	0,0	1	3,5
28	65	1	1	4	1,3	2	0	2	0	1,2	0,5	0	0,0	0	0,0	1	1,2
29	32	3	1	10	2,5	2	0	8	2	16,0	6,4	1	2,5	0	0,0	1	6,0
30	51	2	0	4	2,3	0	2	2	0	4,0	1,6	0	0,0	0	0,0	1	1,0
31	60	1	1	4	1,5	1	1	2	0	3,2	1,3	0	0,0	0	0,0	1	1,2
32	52	1	1	10	2,3	3	2	5	0	10,0	4,0	1	6,0	0	0,0	0	0,0
33	67	3	1	3	2,0	1	0	2	0	8,0	3,2	0	0,0	0	0,0	1	8,0
34	60	1	1	4	1,8	1	1	2	0	1,0	0,4	0	0,0	0	0,0	1	1,0
35	34	1	1	4	1,5	0	2	2	0	1,0	0,4	0	0,0	0	0,0	1	1,0
36	32	2	1	5	1,5	0	2	3	0	0,6	0,3	0	0,0	0	0,0	1	0,6
37	30	2	1	5	1,5	0	2	3	0	1,3	0,5	0	0,0	0	0,0	1	1,3
38	56	2	1	7	1,3	3	0	4	0	9,0	3,6	0	0,0	0	0,0	1	4,0
39	65	1	1	5	2,0	1	0	4	0	1,4	0,6	0	0,0	0	0,0	1	1,0
40	36	2	1	5	2,0	1	1	3	0	2,0	0,8	0	0,0	0	0,0	1	2,0
41	40	1	1	2	1,5	1	1	0	0	1,0	0,4	0	0,0	0	0,0	1	1,0
42	40	1	1	6	1,7	2	0	4	0	1,0	0,4	0	0,0	0	0,0	1	1,0
43	45	1	1	5	1,8	3	0	2	0	2,0	0,8	0	0,0	0	0,0	1	2,0
44	40	2	1	8	2,6	2	6	0	0	4,0	1,6	1	3,0	0	0,0	1	4,0
45	48	1	1	5	1,5	0	4	1	0	0,2	0,1	0	0,0	0	0,0	1	0,2
46	37	1	1	7	2,0	0	2	5	0	2,0	0,8	0	0,0	0	0,0	1	2,0
47	47	1	1	6	1,0	0	3	3	0	1,3	0,5	0	0,0	0	0,0	1	1,3
48	57	1	1	2	1,0	1	1	0	0	1,0	0,4	0	0,0	0	0,0	1	1,0
49	55	1	1	4	2,0	1	2	1	0	2,0	0,8	1	1,0	0	0,0	1	2,0
50	38	2	1	4	1,5	0	1	3	0	4,3	1,7	0	0,0	0	0,0	1	4,3

Farm	W yes / no	W area (acre / farm)	RFT yes / no	RFT area (acre / farm)	RF yes / no	RF area (acre / farm)	C/T & W yes / no	C/T & W area (acre / farm)	RFT & W yes / no	RFT & W area (acre / farm)	Water Availability (months): C/T	W	RFT	Rice Crops / Year (nr.)	Animal Husbandry (nr.): bullock	dairy	sheep	goat	chicken	elements practiced	Farm Implements Owned: equipments (nr.)	machines (nr.)	Farm Wealth (****)
1	0	0,0	0	0,0	0	0,0	1	12,0	0	0,0	10	12	-	2	0	0	0	0	0	0	1	2	3
2	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	10	-	-	2	0	5	0	0	0	1	1	0	1
3	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	10	-	-	2	0	0	0	0	0	0	2	0	2
4	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	10	-	-	2	0	0	0	0	0	0	2	0	1
5	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	10	-	-	2	0	0	0	0	0	0	1	0	1
6	1	7,0	0	0,0	0	0,0	0	0,0	0	0,0	10	12	-	2	2	4	6	0	16	4	3	2	3
7	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	10	-	-	2	2	0	2	0	6	3	2	0	2
8	1	1,0	0	0,0	0	0,0	0	0,0	0	0,0	10	12	-	2	2	0	0	0	0	1	1	0	3
9	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	10	-	-	2	0	0	0	0	4	1	1	0	1
10	1	25,0	0	0,0	0	0,0	0	0,0	0	0,0	10	12	-	2	2	4	0	0	10	3	2	4	3
11	1	2,4	0	0,0	0	0,0	0	0,0	0	0,0	6	12	-	2	0	0	0	0	2	1	2	0	1
12	1	4,0	0	0,0	0	0,0	0	0,0	0	0,0	10	12	-	2	2	4	0	0	5	3	2	1	2
13	1	1,5	0	0,0	1	7,0	0	0,0	0	0,0	-	12	-	1	0	0	0	15	3	2	1	0	3
14	1	15,0	0	0,0	0	0,0	0	0,0	0	0,0	-	12	-	1	0	1	0	0	0	1	1	0	2
15	1	5,0	0	0,0	0	0,0	0	0,0	0	0,0	10	12	-	2	2	9	0	0	0	2	1	1	3
16	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	10	-	-	2	0	4	0	0	0	1	2	1	3
17	1	9,0	0	0,0	0	0,0	0	0,0	0	0,0	10	12	-	2	0	0	0	0	0	0	2	3	3
18	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	10	-	-	2	0	6	0	0	0	1	2	0	3
19	0	0,0	0	0,0	0	0,0	1	15,0	0	0,0	6	12	-	1	2	8	0	0	10	3	1	2	3
20	1	9,0	0	0,0	0	0,0	0	0,0	0	0,0	6	12	-	2	2	7	0	12	20	4	1	2	3
21	1	1,0	0	0,0	0	0,0	0	0,0	0	0,0	6	12	-	1	0	4	0	0	10	2	0	0	2
22	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	0	0	0	0	2	1	0	0	1
23	0	0,0	0	0,0	0	0,0	1	3,0	0	0,0	6	12	-	2	0	0	2	3	0	2	0	1	3
24	0	0,0	0	0,0	0	0,0	1	4,5	0	0,0	6	12	-	2	0	0	0	0	0	0	0	0	2
25	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	0	0	0	0	5	1	1	0	1
26	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	0	0	0	0	0	0	1	0	1
27	0	0,0	0	0,0	0	0,0	1	1,5	0	0,0	6	12	-	1	4	2	0	6	4	4	5	0	2
28	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	0	0	0	0	2	1	1	0	1
29	1	10,0	0	0,0	0	0,0	0	0,0	0	0,0	6	12	-	1	0	4	2	0	4	3	2	0	3
30	0	0,0	0	0,0	0	0,0	1	3,0	0	0,0	6	12	-	1	0	3	0	3	3	3	3	0	2
31	0	0,0	0	0,0	1	2,0	0	0,0	0	0,0	6	-	-	1	0	0	0	0	0	0	0	0	1
32	1	10,0	0	0,0	0	0,0	0	0,0	0	0,0	-	12	-	1	2	4	0	10	4	4	4	0	2
33	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	0	4	0	3	10	3	3	0	2
34	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	0	2	0	0	5	2	0	0	1
35	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	0	0	0	10	8	2	2	0	1
36	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	0	2	0	6	0	2	0	0	1
37	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	0	2	1	0	2	3	0	0	1
38	0	0,0	0	0,0	0	0,0	1	5,0	0	0,0	6	12	-	2	3	2	0	0	0	2	4	0	2
39	0	0,0	0	0,0	1	0,4	0	0,0	0	0,0	6	-	-	1	0	0	0	0	20	1	1	0	1
40	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	2	6	2	0	0	3	1	1	2
41	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	0	8	0	0	5	2	0	1	1
42	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	0	2	0	0	0	1	0	0	1
43	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	0	4	2	0	6	3	1	0	1
44	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	10	-	-	2	0	4	0	5	0	2	2	0	2
45	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	10	-	-	2	0	0	0	0	3	1	0	0	1
46	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	10	-	-	2	0	0	0	0	0	0	0	0	1
47	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	10	-	-	2	2	5	2	0	1	4	0	0	1
48	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	10	-	-	2	0	0	0	0	0	0	0	0	1
49	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	10	-	-	2	0	0	0	0	7	1	0	0	1
50	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	0	0	0	0	0	0	3	0	2

Typology data sheet (continued)

Farm	Head of Farm			Household Members					Permanent Labour (nr.)	Landholding + Irrigation Source (acre) (***)																		Water Availability (months)			Rice Crops / Year (nr.)	Animal Husbandry (nr.)						Farm Implements Owned		Farm Wealth (****)
	age (yr)	education level (*)	major occupation farming ? (**)	total persons (nr.)	average education level (*)	working fulltime on the farm (nr.)	working parttime on the farm (nr.)	not working on the farm (nr.)		total area		leased in		leased out		C/T		W		RFT		RF		C/T & W		RFT & W		C/T	W	RFT		bullock	dairy	sheep	goat	chicken	elements practiced	equipments (nr.)	machines (nr.)	
										Acre	Ha	yes / no	area (acre / farm)	yes / no	area (acre / farm)	yes / no	area (acre / farm)	yes / no	area (acre / farm)	yes / no	area (acre / farm)	yes / no	area (acre / farm)	yes / no	area (acre / farm)	yes / no	area (acre / farm)													
51	40	1	1	6	1,0	0	1	5	0	1,0	0,4	0	0,0	0	0,0	1	1,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	0	0	0	0	0	0	0	0	1
52	51	1	1	6	1,0	0	1	5	0	2,0	0,8	0	0,0	0	0,0	1	2,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	0	4	0	0	10	2	0	0	1
53	62	2	1	5	1,6	1	2	2	0	2,0	0,8	0	0,0	0	0,0	1	2,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	0	2	2	0	8	3	0	0	1
54	80	1	1	2	1,0	1	1	0	0	3,0	1,2	0	0,0	0	0,0	1	3,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	0	0	0	0	0	0	0	0	1
55	48	1	0	4	1,5	1	2	1	0	4,3	1,7	1	4,0	0	0,0	1	4,3	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	10	-	-	2	0	4	0	0	0	1	2	0	2
56	52	1	1	6	3,0	2	0	4	0	2,0	0,8	0	0,0	1	0,5	1	1,5	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	10	-	-	2	0	4	0	0	0	1	2	0	1
64	62	1	1	4	1,3	1	1	2	0	12,0	4,8	0	0,0	0	0,0	1	12,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	0	0	3	0	3	2	1	0	2
65	62	2	1	2	2,0	1	0	1	1	10,0	4,0	0	0,0	1	5,0	0	0,0	0	0,0	0	0,0	0	0,0	1	5,0	0	0,0	10	12	-	2	0	0	0	0	0	0	0	0	3
66	61	3	1	5	2,4	0	4	1	0	3,5	1,4	0	0,0	0	0,0	1	2,0	1	1,5	0	0,0	0	0,0	0	0,0	0	0,0	6	12	-	2	0	0	0	0	0	0	1	0	2
67	53	1	1	3	1,7	2	0	1	0	1,5	0,6	0	0,0	0	0,0	1	0,5	1	1,0	0	0,0	0	0,0	0	0,0	0	0,0	6	12	-	2	0	7	0	0	0	1	2	0	2
68	70	1	1	2	1,0	2	0	0	0	3,0	1,2	0	0,0	0	0,0	1	1,0	1	2,0	0	0,0	0	0,0	0	0,0	0	0,0	10	12	-	2	0	3	0	0	0	1	2	0	2
69	60	1	1	4	1,0	1	2	1	0	0,8	0,3	0	0,0	0	0,0	1	0,8	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	6	-	-	1	0	5	0	0	1	2	0	0	1
70	65	1	1	2	1,0	0	2	0	0	0,6	0,3	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	1	0,6	0	0,0	6	12	-	2	0	0	0	0	0	0	0	0	1
71	70	1	1	2	1,0	1	0	1	0	2,0	0,8	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	1	2,0	-	12	6	1	0	2	0	0	0	1	0	0	1
72	48	2	1	6	1,8	0	2	4	0	6,0	2,4	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	1	6,0	-	12	6	1	0	0	0	0	0	0	0	0	2
73	33	2	1	5	1,7	0	2	3	0	3,5	1,4	0	0,0	0	0,0	0	0,0	1	3,5	0	0,0	0	0,0	0	0,0	0	0,0	-	12	-	1	0	0	0	0	5	1	1	0	2
74	45	1	1	3	1,0	0	2	1	0	3,0	1,2	0	0,0	0	0,0	0	0,0	1	1,0	0	0,0	1	2,0	0	0,0	0	0,0	-	12	-	1	0	0	0	0	2	1	0	0	1
75	45	1	1	4	1,0	2	1	1	0	1,8	0,7	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	1	1,5	0	0,0	1	0,3	-	12	6	1	2	4	0	0	10	3	0	0	1
76	50	1	1	4	1,5	0	2	2	0	3,5	1,4	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	1	3,5	-	12	6	1	0	0	0	0	4	1	0	0	2
77	67	1	1	2	1,0	1	1	0	0	10,0	4,0	0	0,0	0	0,0	0	0,0	1	2,0	1	3,0	0	0,0	0	0,0	1	5,0	-	12	6	1	0	0	1	0	3	2	1	0	2
78	55	1	1	3	1,3	0	2	1	0	5,8	2,3	1	0,8	0	0,0	0	0,0	1	2,5	1	0,8	1	2,5	0	0,0	0	0,0	-	12	6	1	0	4	1	0	3	3	1	0	1
79	38	1	1	4	1,0	0	2	2	0	4,1	1,6	1	0,8	0	0,0	0	0,0	0	0,0	1	1,1	1	3,0	0	0,0	0	0,0	-	-	6	1	0	0	0	0	0	0	0	0	1
80	83	1	1	4	1,3	1	2	1	1	2,3	0,9	0	0,0	0	0,0	0	0,0	1	0,5	1	0,3	1	1,5	0	0,0	0	0,0	-	12	6	1	0	0	0	0	0	0	0	0	2
81	66	2	1	3	1,3	1	1	1	0	1,2	0,5	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	1	1,2	-	12	6	1	0	0	0	0	4	1	0	0	1
82	65	2	1	4	1,8	1	0	3	2	7,0	2,8	0	0,0	0	0,0	0	0,0	1	5,0	1	2,0	0	0,0	0	0,0	0	0,0	-	12	6	1	0	0	0	0	0	0	0	0	2
83	52	1	1	3	1,3	0	2	1	0	1,8	0,7	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	1	1,8	-	12	6	1	0	0	0	0	3	1	0	0	1
84	47	1	1	4	1,0	0	2	2	0	3,0	1,2	1	3,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	1	3,0	-	12	6	1	0	0	0	0	0	0	0	0	2
85	59	1	1	7	1,8	0	3	4	0	9,0	3,6	0	0,0	0	0,0	0	0,0	1	4,0	1	5,0	0	0,0	0	0,0	0	0,0	-	12	6	1	0	3	0	0	4	2	1	1	3
86	45	1	1	5	1,2	0	2	3	0	2,0	0,8	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	1	2,0	-	12	6	1	0	2	0	0	4	2	1	0	1
87	50	1	1	5	1,0	2	2	1	0	1,0	0,4	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	1	1,0	-	12	6	1	0	2	0	0	4	2	0	0	1
88	37	1	0	5	1,2	0	2	3	0	1,0	0,4	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	1	1,0	-	12	6	1	0	2	0	0	0	1	0	0	1
89	49	1	1	6	1,0	0	3	3	0	3,6	1,4	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	1	1,2	0	0,0	1	2,4	-	12	6	1	2	1	0	0	0	2	0	0	2
90	37	2	1	7	1,3	1	3	3	0	3,4	1,4	0	0,0	0	0,0	0	0,0	1	3,0	1	0,4	0	0,0	0	0,0	0	0,0	-	12	6	1	0	0	0	0	6	1	0	0	2
91	66	2	1	5	2,2	0	3	2	0	3,0	1,2	1	1,0	0	0,0	0	0,0	1	1,0	1	2,0	0	0,0	0	0,0	0	0,0	-	12	6	1	0	0	0	0	0	0	0	0	2
92	55	1	1	4	1,0	0	2	2	0	2,0	0,8	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	1	2,0	-	12	6	1	0	0	1	0	2	2	0	0	1
93	53	1	1	4	1,5	0	2	2	0	8,0	3,2	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	1	8,0	-	12	6	1	0	0	0	0	0	0	0	1	2
94	68	1	1	7	1,0	1	3	3	0	5,0	2,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	1	3,0	0	0,0	1	2,0	-	12	6	1	0	2	0	0	0	1	1	0	2
95	46	2	1	4	1,5	0	2	2	0	6,0	2,4	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	1	4,5	0	0,0	1	1,5	-	12	6	1	0	2	0	0	0	1	1	1	3
96	40	2	1	5	1,5	0	2	3	0	3,0	1,2	0	0,0	0	0,0	0	0,0	1	3,0	0	0,0	0	0,0	0	0,0	0	0,0	-	12	-	1	0	4	0	0	0	1	0	0	2
97	49	1	1	5	1,0	1	3	1	0	15,5	6,2	0	0,0	0	0,0	0	0,0	1	0,5	0	0,0	1	15,0	0	0,0	0	0,0	-	12	-	1	0	0	0	0	0	0	0	0	2
98	66	1	1	3	1,7	1	1	1	0	2,5	1,0	0	0,0	0	0,0	0	0,0	1	1,0	0	0,0	1	1,5	0	0,0	0	0,0	-	12	-	1	0	4	0	0	0	1	0	0	1
99	63	1	1	3	1,7	0	1	2	1	5,0	2,0	1	1,0	0	0,0	0	0,0	1	2,0	0	0,0	1	3,0	0	0,0	0	0,0	-	12	-	1	0	2	0	0	0	1	0	0	2
100	47	1	1	7	1,3	0	2	5	0	2,0	0,8	0	0,0	0	0,0	0	0,0	1	2,0	0	0,0	0	0,0	0	0,0	0	0,0	-	12	-	1	0	0	0	0	0	0	0	0	1

Appendix F: Photo's

Source: Personal photos of the author ©

1: Nursery mat (at Farmer's field)

2: Nursery mat (at AC&RI Killikulam)

3:Removing seedlings from nursery mat (at AC&RI Killikulam)

4: Conoweeder

5: Conoweeder in action

6: Mechanical weeding practice

7: Conventional nursery at 16 day (at AC&RI Killikulam)

8: SRI nursery at 8 day (at AC&RI Killikulam)

9: SRI nursery at farmer's field

10: SRI nursery at farmer's field

11: Conventional seedling at 16 day (L) and SRI seedling at 8 day (R)

12: Farmer's SRI field

13: Farmer's SRI field

14: Farmer's SRI field & Mechanical weeding

15: Line planting (at AC & RI Killikulam)

17: Conventional planting

18: Conventional planted field

16: After transplanting of rice seedlings with line planting technique (at AC & RI Killikulam)

19: Rope for square planting technique

20: Hand weeding by female in farmer's field

21: SRI field (L) & conventional field (R) planted at same date

22: Field preparation at farmer's field with bullocks

23: Field preparation with tractor (at AC&RI Killikulam)

24: Deepening a dried up well

25: Deepening a dried up well with own-made crane

26: Boring a tube well

27: Boring a tube well

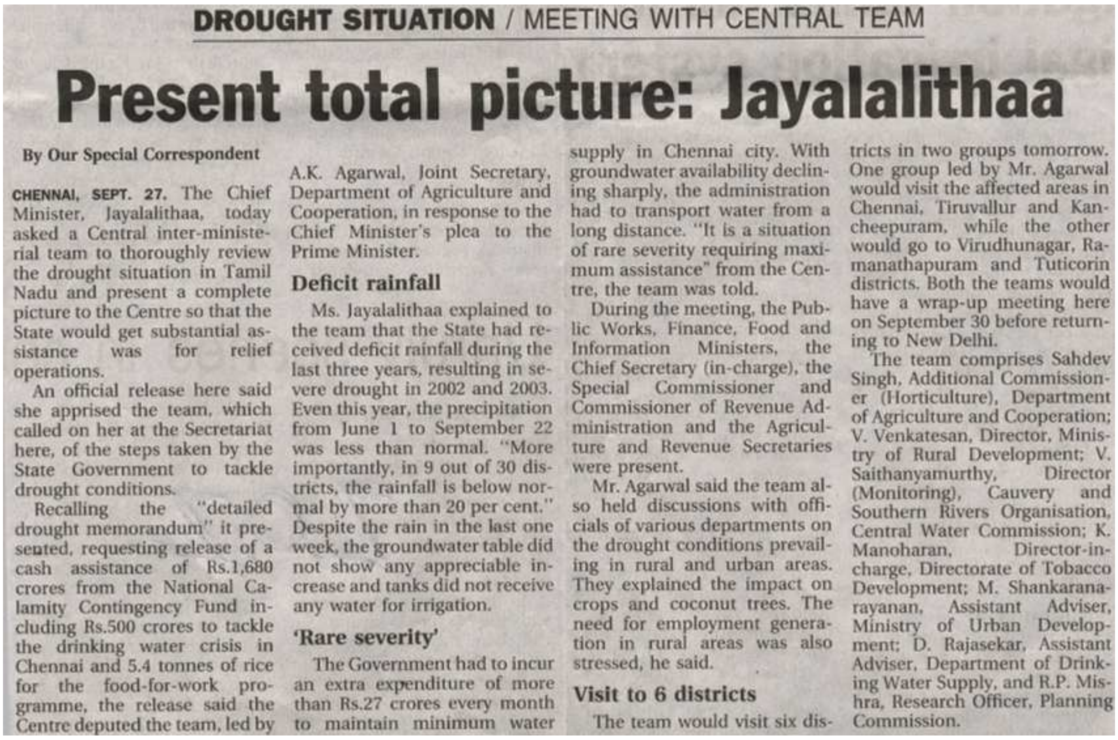
28: Drum seeding device

30: Members of a Self Help Group practicing SRI

29: Drum Seeding device; close-up of a drum

Appendix G: Newspaper articles

Source: *The Hindu* - 2004



DROUGHT SITUATION / MEETING WITH CENTRAL TEAM

Present total picture: Jayalalithaa

By Our Special Correspondent

CHENNAI, SEPT. 27. The Chief Minister, Jayalalithaa, today asked a Central inter-ministerial team to thoroughly review the drought situation in Tamil Nadu and present a complete picture to the Centre so that the State would get substantial assistance was for relief operations.

An official release here said she apprised the team, which called on her at the Secretariat here, of the steps taken by the State Government to tackle drought conditions.

Recalling the "detailed drought memorandum" it presented, requesting release of a cash assistance of Rs.1,680 crores from the National Calamity Contingency Fund including Rs.500 crores to tackle the drinking water crisis in Chennai and 5.4 tonnes of rice for the food-for-work programme, the release said the Centre deputed the team, led by A.K. Agarwal, Joint Secretary, Department of Agriculture and Cooperation, in response to the Chief Minister's plea to the Prime Minister.

Deficit rainfall

Ms. Jayalalithaa explained to the team that the State had received deficit rainfall during the last three years, resulting in severe drought in 2002 and 2003. Even this year, the precipitation from June 1 to September 22 was less than normal. "More importantly, in 9 out of 30 districts, the rainfall is below normal by more than 20 per cent." Despite the rain in the last one week, the groundwater table did not show any appreciable increase and tanks did not receive any water for irrigation.

'Rare severity'

The Government had to incur an extra expenditure of more than Rs.27 crores every month to maintain minimum water supply in Chennai city. With groundwater availability declining sharply, the administration had to transport water from a long distance. "It is a situation of rare severity requiring maximum assistance" from the Centre, the team was told.

During the meeting, the Public Works, Finance, Food and Information Ministers, the Chief Secretary (in-charge), the Special Commissioner and Commissioner of Revenue Administration and the Agriculture and Revenue Secretaries were present.

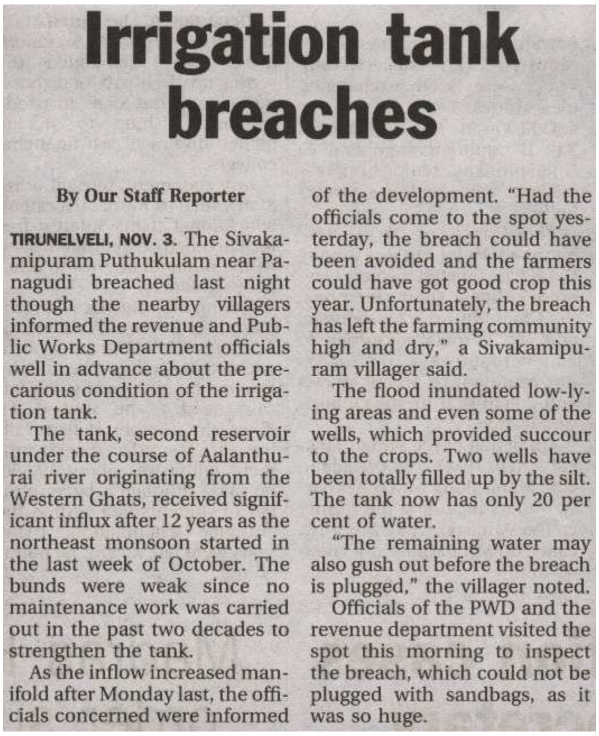
Mr. Agarwal said the team also held discussions with officials of various departments on the drought conditions prevailing in rural and urban areas. They explained the impact on crops and coconut trees. The need for employment generation in rural areas was also stressed, he said.

Visit to 6 districts

The team would visit six districts in two groups tomorrow. One group led by Mr. Agarwal would visit the affected areas in Chennai, Tiruvallur and Kancheepuram, while the other would go to Virudhunagar, Ramanathapuram and Tuticorin districts. Both the teams would have a wrap-up meeting here on September 30 before returning to New Delhi.

The team comprises Sahdev Singh, Additional Commissioner (Horticulture), Department of Agriculture and Cooperation; V. Venkatesan, Director, Ministry of Rural Development; V. Saithanyamurthy, Director (Monitoring), Cauvery and Southern Rivers Organisation, Central Water Commission; K. Manoharan, Director-in-charge, Directorate of Tobacco Development; M. Shankaranarayanan, Assistant Adviser, Ministry of Urban Development; D. Rajasekar, Assistant Adviser, Department of Drinking Water Supply, and R.P. Mishra, Research Officer, Planning Commission.

1: Present total picture: Jayalalithaa



Irrigation tank breaches

By Our Staff Reporter

TIRUNELVELI, NOV. 3. The Sivakamipuram Puthukulam near Panagudi breached last night though the nearby villagers informed the revenue and Public Works Department officials well in advance about the precarious condition of the irrigation tank.

The tank, second reservoir under the course of Aalanthurai river originating from the Western Ghats, received significant influx after 12 years as the northeast monsoon started in the last week of October. The bunds were weak since no maintenance work was carried out in the past two decades to strengthen the tank.

As the inflow increased manifold after Monday last, the officials concerned were informed of the development. "Had the officials come to the spot yesterday, the breach could have been avoided and the farmers could have got good crop this year. Unfortunately, the breach has left the farming community high and dry," a Sivakamipuram villager said.

The flood inundated low-lying areas and even some of the wells, which provided succour to the crops. Two wells have been totally filled up by the silt. The tank now has only 20 per cent of water.

"The remaining water may also gush out before the breach is plugged," the villager noted.

Officials of the PWD and the revenue department visited the spot this morning to inspect the breach, which could not be plugged with sandbags, as it was so huge.

2: Irrigation tank breaches

Rain causes collapse of houses, breach of tanks

By Our Staff Reporter

TIRUNELVELI, NOV. 9. Rain wrecked havoc in some parts of Tirunelveli district close to the Western Ghats, thanks to the breach in two irrigation tanks and a channel as a result of widespread drizzle that continued in the district for the second day today.

Flood entered Thiruvalluvar Nagar and Marutham Nagar near Vickramasingapuram after a breach in the Kodaimelazhagiyan channel. The rainwater also inundated the main road at Tana.

Due to the flood in Ramanadhi, vehicular traffic between Ambasamudhrai and Tenkasi was affected and the vehicles were diverted through Idaikaal. The Agampillai and Thaamari tanks near Azhwarkurichi breached today, bringing the floods into the nearby villages. The floods also hit the vehicular traffic badly.

The Kozhumadaikulam at Maththalampaarai near Courtallam also breached owing to good rains in the Western Ghats.

Since the rain continued in the catchment areas, bringing good influx into Papanasam and Servalar dams, people in the low-lying areas have been asked to move to safer places. The level in Papanasam, which stood at 118.05 feet this morning, moved to 122 feet (full capacity 143 feet) this evening, while the storage level at Servalar dam, which stood at 131.89 feet this morning, rose to 137 feet (full capacity 156 feet) this evening.

"If the overnight rain brought a huge inflow into the dams, particularly, Servalar dam, water may be released at any time," PWD sources said tonight.

The rain also caused the collapse of two houses in the district, injuring four women.

In the first incident at Vellankuzhi near Veeravanallur, Lakshmi (35), Ramani (32) and another Lakshmi (45) were injured when a house fell down as a mud wall was damaged by the rain. In the second incident at Palayamkottai, Velammal (60) was injured.

All the injured have been admitted to the Tirunelveli Medical College Hospital.

For the first time in recent years, all the waterfalls at Courtallam, particularly, the Mainfalls, received a massive inflow, keeping revellers away from the falls.

3:Rain causes collapse of houses, breach of tanks

Plentiful rain, flowing river and yet barren land

By P. Sudhakar

TIRUNELVELI, NOV. 19. Though Tirunelveli district has had plentiful rain ever since the monsoon started in the third week of October, several lakhs of cusecs of the Tamiraparani are being let into the Gulf of Mannar while several thousands of acres of land are still barren and over 200 irrigation tanks in certain areas are dry even now.

After the level in the major irrigation dams of Papanasam and Servalar touched a couple of feet below the maximum capacity, several thousands of cusecs of water were discharged into the river, which travels slightly over 125 km from the Western Ghats to reach the estuary at Punnaikaayal, a fishermen hamlet near Tiruchendur. Since all irrigation tanks, which are being fed by the channels arising from the dams, are already brimming with water, thanks to the active monsoon, the latest release of water is being just wasted.

However, environmentalists here feel that every drop of this huge quantity of water could be judiciously used if the Government dug a couple of new channels and desilted waterways to provide water for irrigation and drinking to more areas whenever the Tamiraparani swells.

The first floodwater channel may originate from any one of the advantageous points from the river to help the population in the entire Vilaaththikulam and Ottapidaram taluks in Tuticorin district and a number of wayside habitations in Tirunelveli district.

The second channel, actually announced and christened by the Chief Minister, Jayalalithaa, as the 'Sattankulam-Thisayanvilai Channel' immediately after the Sattankulam by-election, may arise at the end of the Kannadiyan channel at Mela Seval near here.

"Industries, both government and private, in and around Tuticorin may be roped in for the execution of the first channel as they utilise a sizable share of the total drinking water being supplied to the port town. The Government should effectively play the role of a facilitator, as issues such as land acquisition should neither delay nor scuttle this noble exercise. With the Centre actively pushing the Sethusamudhram project, Tuticorin will require a huge quantity of drinking water in the near future and so, the Government should strengthen the infrastructure to utilise the flood water," said a top PWD official here.

Though he refused to divulge the details of the channels to be constructed here to effectively carry floodwaters from the Tamiraparani to the rain-shadow regions, he admitted that his department had sent proposals to the Government for its nod.

While the idea of maximum utilisation of the Tamiraparani floods needs an exhaustive discussion, meticulous planning and finally, bold decision-making, the Government can now at least discharge the floods from the Manimuthar dam to Fourth Reach during this season to fill the desiccated tanks in the rain shadow regions of Radhapuram and Nanguneri taluks in Tirunelveli district and Sattankulam taluk in Tuticorin district since most of the tanks under the First and Second Reach are already full.

If the excess water is discharged to the Fourth Reach after the dam moved up to the maximum capacity of 118 feet from the present 113.4 feet, Suviseshapuramkulam, Pattancherrykulam, Vijaya Achchampaadukulam, Singasaavadikulam, Subramaniyapuramkulam, Puthukkulam, Kalkulam, Nandankulam, Sengulam, Muthalaalikulam, Kuruvisuttaankulam, Appuvilaikulam, Yerumaikulam, Aavichchaankulam, Aayanpadugaikulam, Aanaikudipadugaikulam, Elakkulam, Kadaakulam and Puththantharuvaikulam can be filled up to start farming operations in these areas nearly after a decade and augment the ground water table to a greater extent.

"If the Government fails to take steps to release the surplus water to the Fourth Reach once the Manimuthar dam reaches 117 feet, again we'll lose several lakhs of cusecs of precious 'white gold' while some of our brethren and their cattle are badly craving for drinking water," said a tahsildar.

4: Plentiful rain, flowing river and yet barren land

70-80 per cent samba crop lost, say officials

By our Staff Reporter

NAGAPATTINAM, NOV.3. The three-member committee headed by Jagmohan Singh Raju, Commissioner of Agriculture, set up by the State Government to assess flood damage began its work in Nagapattinam today. The two other members of the committee are superintending engineers from the Highways and the Public Works Departments.

The Nagapattinam Collector, M. Veera Shanmugha Moni, the Joint Director of Agriculture, Nagapattinam, G. Saminathan, and other officials accompanied the team and showed them the damages to the samba paddy crop, roads, irrigation channels and tanks on the Nagapattinam-Mayiladuturai stretch this afternoon.

The panel visited a number of villages including Keezhaiyur, Needur, Anathandavapuram, Kadagam and Arivanur in Mayiladuturai taluk and assessed the damage, interacting with farmers and local people in the villages.

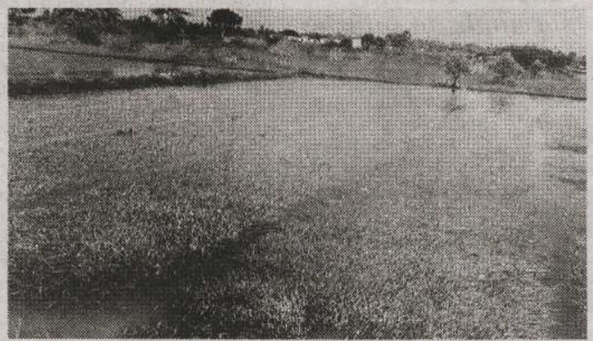
Mr. Moni told *The Hindu* that the panel would visit the areas adjoining Nagapattinam till tomorrow noon. Agriculture Department officials in Nagapattinam told the Commissioner that there was no possibility of saving 70 to 80 per cent of the submerged samba paddy crops in the district even after the water receded.

The panel will go to Tiruvarur district tomorrow afternoon and visit several parts of Thanjavur district on Friday to assess the damage.

Meanwhile, Arupathi Kalyanam, general secretary of the Federation of Farmers Associations in Thanjavur, Tiruchi and Nagapattinam districts, have urged the Government to pay compensation of Rs.8,000 per acre for the rain-damaged crops.

He said that not desilting the irrigation channels in the last three years had led to the heavy inundation of paddy fields this year.

He said samba paddy crops in more than two lakh acres were damaged in the Cauvery delta region of Thanjavur, Tiruvarur and Nagapattinam districts during the recent heavy rains and that the damage was the worst in Nagapattinam district.



A heavily submerged paddy field on the Nagapattinam-Mayiladuturai road.

5: 70-80 per cent samba crop lost, say officials

Rise in suicides by farmers

By Muralidhara Khajane

HASSAN, OCT. 31. With the death of Kari Gowda of Junjanahalli in Dudda limits of Hassan taluk, the number of suicides by farmers in the district has gone up to 92 since April 2003. This is said to be highest in the State. Kari Gowda consumed pesticide after he realised that he would not able to repay the loan he had borrowed from a co-operative society and a moneylender to cultivate his land.The district recorded 73 cases of suicide by farmers till April 1, 2004, and 19 cases have been reported in the past five months, according to sources in the district administration. While Arsikere taluk recorded five suicide cases — the highest in the district — only one case was recorded in Arakalgud taluk. The cases recorded in other taluks in the district are: Sakleshpur (2), Alur (4), Belur (2), Hassan (2), and Channarayapatna (2).

Compensation

The sources disclosed that of the 73 cases of suicide recorded in the State till April 2004, compensation had been paid only in 18 cases; relief in other cases was rejected on various grounds. The increasing number of suicides by farmers is an indicator of the crisis in the agricultural sector.Though farmers who grew potato in the district were relieved with the early arrival of monsoon, the dry spell later was frustrating for them. Now they have lost the crop, according to the sources. The plight of farmers growing coffee and cardamom is much the same.

Charge

The Karnataka Rajya Raitha Sangha (KRRS) has blamed the Government for the increasing number of suicides in the district. The general secretary of KRRS, Kodihalli Chandrashekar, accused the Government of failing to settle the crop insurance claims in time which forced them to be at the mercy of moneylenders. He said that compensation for the crop losses in the past two years had not reached the farmers. They were also yet to receive the crop insurance amount of Rs. 122 crores. The sources said that the farmers were yet to receive compensation to the tune of Rs. 2.5 crores for 2002-03. A total of 1,041 farmers had not been paid compensation so far. Mr. Chandrashekar said that the crop insurance money had not reached the farmers as financial institutions had adjusted the claims against the loan borrowed by them.

Though the Government had directed the financial institutions against adjusting the crop insurance claims towards the loan taken by farmers, the institutions were adjusting the claims towards the outstanding debts of previous years. The high premium and reduction in subsidy to small and marginal farmers had aggravated the situation, he said.

Crop failure, lack of irrigation facilities in the taluks, especially in Arsikere, pest attack, family problems, and harassment by moneylenders are cited as the reasons for the spate of suicides in the district.

6: Rise in suicides by farmers

'Sanction fresh loans to farmers'

By Our Staff-Reporter

TIRUCHI, NOV.4. The Tamizhaga Vivasayigal Sangam has urged the Centre and the State Government to sanction fresh loans to farmers for taking up farming activity.

In a resolution adopted at its State executive committee meeting held here recently, it recalled that the Centre had announced an increase in flow of farm credit through banks, exceeding the achievement registered during the last financial year by 30 per cent, and the State Government had announced a special loan package of about Rs. 1,000 crores.

But banks were sanctioning loans only to those who had completely repaid their dues. They did not grant loans to those farmers, whose loans had been deferred. The sangam urged the Centre and the State Government to write off overdues and sanction fresh loans. Otherwise, it would launch an agitation all over the State, a resolution said.

By another resolution, it urged the Centre to enable Tamil Nadu get its due share of Cauvery water from Karnataka. The Karnataka Government should be asked to protect the riparian rights of Tamil Nadu farmers by honouring the interim award of the tribunal. The State Government also should take action for implementation of the tribunal's award.

Another resolution wanted drought relief for drought-hit farmers. Mango cultivators in Dharmapuri and Salem districts, and coconut growers in a number of districts had been hit hard due to successive drought, the resolution said seeking adequate relief to the affected farmers.

The State president of the Sangam, S. Gunasekaran, presided. The State secretary, V. Duraimanickam, the Tiruchi district president, Sivasooriyan, spoke.

7: Sanction fresh loans to farmers

Bank gesture to relieve farmers from usury

By Our Staff Reporter

MADURAI, NOV. 10. The State Bank of India's Agriculture Development Bank branch today gave away Rs.5000 each as loan to 72 farmers/traders of the Chockikulam 'Uzhavar Sandai' to relieve them from the clutches of usury moneylenders.

The SBI will cover 150 farmers/traders of the Anna Nagar Farmers' Market and the Central Vegetable Market in the coming days.

A team of bank officials monitored the business transaction of the farmers for the past two months, which brought out the plight of a section of farmers, who were paying exorbitant rates of interest to usurious moneylenders. "Just to help them come out of the grip of money lenders, we decided to give them a loan, which could be used as a capital for their business," the ADB Manager, Seetharaman, said.

One of the farmers, Pandi, said that over 150 farmers/traders in the Chockikulam market were at the mercy of around 10 usury moneylenders.

"For a loan of Rs.1000, they give only Rs.840 and the remaining Rs.160 is withheld as interest. The money has to be repaid in 120 days – at the rate of Rs. 10 per day. We have to pay Rs.300 per month. Even a default in repayment for a week's time will incur an additional interest," he said.

"When we took loans from the traders, we lost our bargaining power and had to buy vegetables at a higher rate, and sometimes vegetables of poor quality," he said.

t a time when these farmers were finding it difficult to manage the interest rates, the officials from the SBI intervened.

The farmers now need to pay only Rs.250 per month even for a Rs.5000 loan. The rate of interest is 8.5 per cent and the loan could be repaid in 24 months.

"If they are prompt in repayment, nothing will stop us from providing them more loans," Mr. Seetharaman said.

Besides, these farmers can easily approach the bank for crop loans also.

This is the first time that the officials are going in search of deserving beneficiaries and based on the success of the venture, it would be extended to other parts of the State, a bank official said.

The SBI Deputy General Manager, M.P. Muralidharan, and the Assistant General Manager, S. Venkataraman, distributed loans to the farmers/traders.

8: Bank gesture to relieve farmers from usury

Call for collective efforts to curb corruption

By Our Staff Reporter

MADURAI, NOV.4. The need for collective efforts to curb corruption in all its forms was emphasised at a seminar organised by the Southern Railway's Madurai Division here on Wednesday.

The Commissioner for Disciplinary Proceedings, V. Irai Anbu, said corruption was being practised in an organised manner in almost all departments and private organisation. That corruption had been prevalent since time immemorial was no excuse to justify the evil practice. "It has to be condemned in all its forms since it will not only degrade services but also destabilise the nation by weakening its infrastructure."

He said causing wrongful loss to the Government for personal gains and flouting the rules to favour an individual for different reasons were common among corrupt practices.

The consequences of corruption varied between poor services or sub-standard work to brain drain. "When the infrastructure here is not up to the international standards, the young graduates and technocrats tend to go abroad for higher studies or employment."

He said corruption was rampant in areas where the people were over-dependent on the Government. Even when trade and commerce flourished, bribery gained prominence since the businessmen looked for quick money and sought officials' cooperation for favours out of way. "The people should shun the tendency to jump the queue".

Recalling some historical facts from the life of the former American President, Abraham Lincoln, and Mahatma Gandhi, Mr. Irai Anbu said children should be exposed to the life history of leaders, who set exemplary standards by their simplicity and honesty. "The students will try to follow the principles preached by such leaders."

Lauding the passenger amenities at the Madurai railway station, he said the success of any organisation depended on how people-friendly it was.

The railway station had recorded a significant growth in recent years.

"The good work of dedicated and honest employees should be recognised to encourage them," he added.

The Deputy Superintendent of Police (Directorate of Vigilance and Anti-Corruption), K. Srinivasagam, said transparency in an organisation would automatically minimise corruption.

The lack of a stiff resistance from the public to oppose corruption was encouraging the wrongdoers to go scot-free.

9: Call for collective efforts to curb corruption

Move to popularise 'rice intensification' technique

By Our Staff Reporter

PUDUKOTTAI, NOV.13. The district administration has planned to hold 1,250 'System of Rice Intensification' demonstrations at various places in the district during the current financial year to create an awareness of this technique to farmers.

Stating this recently at a farmers' gathering at Kurumbur in Aranthangi block after inspecting farm activities and inaugurating a training programme on vermi compost of agricultural waste, he said that adoption of SRI practice would ensure more yield with less requirement of water to the tune of 40 per cent. The SRI demonstrations were held at 500 plots during the last financial year.

The Collector said that farmers should produce and apply vermi-compost in their holdings to enrich the soil content. Vermi-compost was the best organic product.

A Conoweeder demonstration was arranged when the Collector distributed Conoweeder and LCC card to 10 beneficiaries.

According to the Joint Director, Agriculture, R. Angurajan, four vermi composting demonstrations, 100 hybrid rice demonstrations and 206 SRI demonstrations were being held under the Cereal Development Programme through the Agriculture Department.

The Collector inspected coir pith composting demonstration, conducted under the Coconut Development Board Scheme of Agricultural Department with a subsidy of Rs. 20,000.

Officials attached to the Agriculture Department, who accompanied the Collector, explained the farm activities being carried out in this Rabi season.

10: Move to popularise 'rice intensification' technique