CHAPTER 1

INTRODUCTION

Agriculture is the backbone of the Indian economy and is central to its economic development. It accounts for almost 27 per cent of country's GDP, provides employment to around 65 per cent of the total work force, contributes to 21 per cent of total exports and continues to be the primary source of living for 70 per cent of the population, which is in 2003 is about 1.02 billion. Agriculture also provides raw material to several industries and therefore technical progress in agriculture is crucial for the overall economic development of the country. Besides, an estimated 100 million farmers are engaged in agriculture in India (Annual Report/DARE, 1999-2000). Rice is the staple food for 65 per cent of the population and therefore, increased and sustained production of rice is fundamental to food security in India (DRR, 1996).

Similarly, agriculture has been the mainstay of the Sri Lankan economy and has remained so throughout, maintaining its share of GDP at about 20 per cent at present. It provides employment to 23 per cent of the population, which is approximately 19 million in 2003. Although its proportion of the total exports has declined from 63 per cent in 1993 to 23 per cent in 1997, agriculture is still the main foreign exchange earner. This has been partly due to the increase of values of industrial exports, and partly due to the low production of the main export tree crops- tea, rubber and coconut (Senanayake, 2000). Estimated 1.8 million farmer families are engaged in agriculture. In Sri Lanka too, rice production is crucial as it is the only source of staple food consumed by the majority of Sri Lankans. By the year 2000, the annual demand for rice was 3.11 million tonnes whereas the annual production was 2.84 million tonnes (Abeysiriwardena, 2001). This gap is likely to increase as the years go by and increasing rice production, therefore becomes on line.
In the post war period, particularly, around early 1960s, most of the developing countries had to face acute shortage of food grains. They realized that the system of agricultural research and extension that they inherited from the colonial regimes were ineffective and inadequate to provide required technologies for increasing food production. Hence many of the developing nations started making efforts to invest and build their agricultural research, education and extension systems. Such investments in agricultural research, mostly in the 1960s and 1970s, had their profound impact on agricultural research and education, which enhanced the process of evolution of National Agricultural Research Systems (NARS), especially in the Asia-Pacific region (Asopa and Beye, 1997). The constitution and operation of NARS assumed considerable significance as this system had the main objective to bring together different actors to interact in the process of innovations in agriculture at the macro societal level. From the perspective on National System of Innovation (NSI) studies (see Lundvall, 1992; Nelson, 1988), NARS may be also considered as NSI constituting the agriculture research system component (see also Sulaiman and Hall 2002). At the national level, universities, R&D institutions, scientific community and extension system constitute this system which link up to the needs and demands of society and market institutions. The NARS is a network management system at the national level to manage innovation of agricultural research technologies, wherein, the basic sciences at the universities and R&D institutions and the organization of agriculture scientific communities, the government agencies and extension centres have an important role to play in the overall system.

NARS in developing countries have grown rapidly over the last 25 years as a result of increasing investment. By 1980s, more than 80,000 agricultural researchers were working in the NARS of the developing world. During 1961-85, the average size of a developing country NARS increased from 155 to 630 fulltime researchers. There is wide diversity across countries in size and maturity of NARS. China and India have the largest research capacity. It is reported that, 95 of 130 NARS in the developing countries still employ fewer than 200
researchers and 39 research systems employ fewer than 25 researchers (Byerlee and Alex, 1998). It is rather pertinent to point out that by calling a national agriculture institutional set-up such as NARS, that a system geared to forging linkages between different actors with potential innovative capacities is constituted. There are fully developed large NARS as in India and China and there are small, weak and underdeveloped NARS as in several South Asian and African countries.

India has one of the largest agricultural research systems in the world with the largest number of scientific personnel of many developing countries except China. The research system includes approximately 30,000 scientists and more than 100,000 technical and supporting staff actively engaged in agricultural research. Components of the NARS in India are the Indian Council of Agricultural Research (ICAR) at the national level and the agricultural universities at the state level. Besides, several other agencies such as general universities, scientific organizations, extension centers and other government departments of the Central and State and also private and voluntary organizations participate directly or indirectly in research activities related to agriculture system (Parathasarathy, 1997).

In the case of Sri Lanka, the Organization and Structures (O&SSs) concerned with the agricultural R&D are distributed among no less than 14 institutions based in 6 government Ministries (Senanayake, 2000). There are about 450 agriculture scientists working in these institutions. This is in contrast to the R&D institutions under ICAR in India, which come only under the responsibility of the Union Ministry of Agriculture. The NARS of Sri Lanka comprises of two main streams; the R&D institutions and the Faculties of Agriculture in the general universities along with one Post Graduate Institute of Agriculture (PGIA). All these institutions are functioning at the national level.

Agricultural research in India and Sri Lanka is largely in the public sector domain. Research in the private sector is meager and confined to in-house R&D of a few input industries. Agricultural research in India is channeled through the ICAR, an apex organization
that allocates resources for research, teaching and frontline extension through a vast network of research institutes and State Agricultural Universities (SAUs). In Sri Lanka, the funds are channeled through various Cabinet Ministries since the R&D institutes come under several ministries.

Over the last three decades the relative success of ‘Green Revolution’ developments in rice research in India and the International Rice Research Institute (IRRI) in the Philippines attracted the attention of social scientists, particularly economists. As the green revolution technology based on high yielding varieties, irrigation, fertilizers and other inputs required heavy financial investments and other economic factors into the NARS, the main preoccupation of agriculture economists has been to investigate the investment pattern, rate of returns, cost and benefits etc., relevant to NARS. It has been shown empirically (Evenson and Jha, 1973) that the investment in agricultural research and extension is the main source of growth in agricultural total factor productivity in India. Overall, the Central government provides 52% of public funding for agricultural R&E in India (Pal and Byerlee, 2003). Pardey and Roseboom (1989) have developed agricultural research expenditure as an indicator series for investment in agricultural research in India. It has also been found that investment in research in agricultural crop sector during the period 1956-1987 has brought 63% of internal rate of returns (Rosegrant and Evenson, 1992). Studies by Rao and Muralidhar (1994) have shown that the annual nominal investment per agricultural scientist during the early 1990s was around Rupees 0.4 million. Kumar and Rosegrant (1995) state that, during 1971-1988, investment in rice research has brought impressive rates of return of 60%. Rajeswari (1995) has identified that research expenditure has delineated from the total expenditure, which also includes education and extension on the basis of share of research in

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1 The green revolution refers to a spectacular improvement that took place in the yields of major food crops (rice, wheat, maize), mainly during in the late 1960s and early 1970s, and most impressively in Asia. The green revolution was characterized by the fast determination of high yielding varieties, i.e. improved seeds results from science based research, as part of the technological package that included irrigation or controlled water supply and improve moisture utilization, fertilizers and pesticides and associated management skills (FAO, 2000).
the total expenditure that underestimates the actual total research expenditure. Ranjitha (1996) has studied the pattern of investment in agricultural research and extension in India by states and crops/crop groups/sectors over time. According to Pal and Singh (1997), the determinants of public investment in research and extension indicate that the investment is positively associated with the demand for agricultural research commodities. In the social sciences, whilst much of the research on NARS is reported on agriculture economics, the sociological, historical and organizational perspectives on NARS have not been paid the deserved attention for research. Further, the concept of NARS as an innovation system looking into linkages between different actors involved in the relevant system and dynamic elements of the system is an entirely new perspective for the science and technology policy studies and analyses. These are some of the main features with which the present study is conceptualized to draw a comparison between Indian and Sri Lankan agriculture research systems.

Since green revolution, many varieties of wheat, rice, maize etc., have been developed using hybridization technology that led to the increase of grain productivity. Moreover, the biotechnology and transgenic research are now coming into focus of advanced research in agriculture. Yet, it is interesting to note that only a few attempts have been made to study the real workforce or the actors who were behind the relative success stories. According to Rogers (1983), that research on agricultural scientists is in an embryonic stage and even in the social sciences, very little empirical work has been reported on scientific personnel. The studies on the research scientists or the scientific communities who generate the crucial knowledge for agriculture research and production are scarce, particularly, in the case of India and Sri Lanka. A few PhD studies have been undertaken on research scientists in India, which are briefly mention below. Laharia (1978) has undertaken conducted a study of personal and organizational variables influencing the productivity of agricultural scientists in 1978. Ramesh Babu (1981) has investigated the determinants of research productivity and scientists' perception in this regard and found that there were eleven significant factors that affect
research productivity of scientists. Kulkarni (1981) has studied the organizational climate in science institutions. Sandhya (1985) has investigated managerial styles and research productivity in scientists for her PhD thesis. Rao (1988) has studied the role-acquisition processes involved in organizational socialization of Indian agricultural scientists to determine the process variables and outcome variables of the organizational socialization. Singh (1989) has conducted a multidimensional study of the women scientists in ICAR. Niranjan et al. (1994a) has studied the gender issues and location specific problems related to scientists working in the NARS in Sri Lanka. The same group has also analyzed the gender perspectives of the scientists working in the NARS in Sri Lanka (Niranjan et al., 1994b). It was, however, noted that the above studies have addressed productivity and organizational climate of the system but none of them has looked into the perspectives of scientific community. Scientific community can be termed as specialist groups or small communities, sharing a set of ‘social’ and ‘cognitive’ values as the core behind the growth of science (Whitely, 1974) and whose emergence is associated with the growth of professionalisation of science (Ben-David, 1971). The link between research and scientific community forms a solid basis for establishment of NARS making the two as important features of the whole system.

While the management of innovation in agricultural research is by and large catalyzed by the NARS in varying forms, agriculture science communities (including higher agriculture education and R&D system) is seen as the most crucial and important part of the NARS in the Indian context. As briefly pointed out earlier, while much of the social science research in agriculture is dominated by agricultural economics, the social and organizational science are beginning to emerge and slowly attracting the attention of science and technology policy researchers. Given the crucial importance of agriculture research in the food security of countries such as India and Sri Lanka, and other developing countries as well, the promotion of agriculture science communities assumes primordial importance. In the era of globalization, conventional forms of technology transfer are unlikely to take place. With WTO and IPR
regimes coming into operation, import of foreign technologies to developing countries will be restricted (Vaidyanathan, 2000). Technological capabilities in agriculture, most fundamentally draws our attention to capabilities in oriented basic research and existence of scientific communities including higher education structures and R&D structures. Much of the research and technical capabilities in agriculture relates to competence in basic sciences. Moreover in developing countries, if endogenous capacities in agriculture research and technological capabilities are to be established – there is little or no alternative other than promoting scientific communities and a national base in agriculture sciences, education, research and extension systems in the NARS (see Krishna et al. 1998). It is from this insight and a perspective that the present study is designed to primarily understand the dynamics of NARS through the study of agriculture science community. It may be noted that except for technical reports carried out for FAO, the World Bank, ISNAR and so on, no in depth studies have been carried out for NARS in India and Sri Lanka in a comparative perspective. One of the basic thrusts of the PhD project is to explore the Indian NARS and rice science community to draw a comparison with the Sri Lankan counterpart. The comparative perspective of the thesis assumes importance, as the Sri Lankan case is relatively a smaller case, compared to the Indian case, in the process of establishing a national agriculture science community and corresponding NARS. On the other hand, the Indian NARS is a larger case with more than three decades of experience; and it is known for having successfully accomplished the green revolution tasks, despite several shortcomings. The Indian NARS also provides a potential case for exploring the growth of agriculture science community and the network of linkages between different segments and actors of the system. Moreover, the Indian NARS is said to have evolved several organizational and institutional innovations in terms of forging linkages between several actors of the system. All these features are seen to provide a comparative ground for drawing lessons of experience and best practices, if any, from the Indian case.
It may be also pointed out that this study is limited to explore a small component of the NARS in India and Sri Lanka with reference to rice research since rice is a major food crop common to both the countries. As will be evident from the review of literature section, the study draws upon a variety of literature and perspectives from sociology of science, S&T policy analysis, and organizational studies, among others. Towards tracing the beginnings and growth of agriculture research in India and Sri Lanka, an historical perspective is employed at a macro-level of exploration. It may be also mentioned that other perspectives are employed at other levels of exploration such as at the NARS level; at the structure and organization of rice science community level; and the rice scientists in the laboratory level.

At the NARS organizational level, on one hand the effective linkage between NARS and the actors or agencies mentioned above is crucial for research and development (R&D) in any agricultural country; on the other hand S&T policies in agriculture, government intervention, financial investments, mechanism of implementation of research output via extension, are essential for efficient functioning of the whole system in the society, at large. Some important insights from organizational studies will be used at this level of analyses.

At the other level, the institutionalization of rice research, professionalization of scientific communities in rice research, their intellectual culture, formation of scientific groups in specialized areas such as plant breeding and biotechnology, publication of research results in journals etc., are seen to play an important part of the NARS.

At the level of laboratories, understanding of scientists in laboratories; structure of linkages of the laboratory with the NARS and rice science community at large; and the social and organizational context of rice research are seen as important part of the project. Perspectives from sociology of science and scientists in organizations literature will be used in the last two levels of exploration.

Since economic investment being only one of the main inputs that are used in research activities, it cannot fully account for or to explain research or its effectiveness. In fact, over a
period of time, it has been realized that socio economic and policy research too is important as laboratory research in the generation of technologies. Further, new stakeholders like private sector, farmer organizations and NGOs have also entered the field of agricultural technology system making it complex and competitive. The institutional and organizational factors mentioned in the above three levels are seen as equally important for organization of NARS as a network within the theoretical framework, for the development of a country. It must also be mentioned that this study has not attempted to evaluate the NARS in the two countries. Therefore, a historical, sociological and organizational approach to explore the NARS in India and Sri Lanka to learn lessons of experience especially for the latter is the research agenda in this study. The following broad and specific objectives were formulated to guide this PhD Thesis.

**Broader Objectives:**

i) To explore how the agriculture research and NARS in India and Sri Lanka have evolved, organized and functioning over the years.

ii) To understand the structure of linkages among different actors or main components of NARS that has strengthened the system in India.

iii) To draw lessons, if any, from the Indian Agricultural Research System to Sri Lanka.

**Specific Objectives:**

i) To explore the thrust areas and the issues of S&T policies relating to agriculture that have shaped the growth and structure of NARS.

ii) To explore the processes of institutionalisation and professionalisation of rice research in India and Sri Lanka.

iii) To study the growth and organization of scientific community and understand the dynamics of linkages among research, teaching and extension in rice research at the level of relevant labs.
iv) To explore the role of advanced rice research technologies in the process of varietal development and how they are institutionalized.

v) To study the institutional and organizational factors influencing the productivity of scientists in rice research laboratories.

vi) To map out lessons of learning, if any, from each other's system of rice research and organization of scientific communities.

Organisation of the thesis

In the light of the broad and specific objectives mentioned above, this PhD thesis is structured as follows:

The section following the present one (Chapter 2) reviews relevant literature or agriculture research studies in India and Sri Lanka. Further, it explores some important aspects of NARS and relevant literature in sociology of science concerning scientific communities professionalisation and organizational framework, which provide useful theoretical perspectives to the empirical research in the dissertation. The Chapter 3 discusses the research methodology and the conceptual base that guided the study. The first section of this Chapter has a note on the perspectives guiding the study. It then describes the methodology used in the study identifying the advantage of the same over other methodologies. It explains important features used in the methodology and the designing of questionnaire. The second section of the Chapter outlines the sampling procedure, data collection and the procedure followed for analysis of data. In the Chapter 4, as a continuation of the literature review mentioned in the Chapter 2, the agricultural research in India and Sri Lanka during the British colonial period and the period after independence is discussed. It also reviews the S&T policies towards agriculture adopted during the colonial period and by the government after independence. Chapter 5 is the biggest component of the study, where the contemporary national agricultural research systems in India and Sri Lanka, are discussed. The first sector gives the concept and establishment of NARS etc. The second section will discuss the
contemporary NARS with reference to Indian and Sri Lankan models identifying their specificities. The third section mentions the agricultural research policies and S&T policies relevant to agricultural research adopted in the two countries. The fourth section discusses the agricultural science communities in the two countries in general; their growth, size, significance etc.. The last section deals with the organizational and institutional innovations responsible for dynamics of NARS. It also briefly mentions about the actors, societies and structure of linkages of the system with reference to research, teaching and frontline extension. The Chapter 6 concentrates on the scientific community and organization of rice research in India and Sri Lanka. The first section of this chapter discusses the origin and growth of rice science community in the two countries in terms of size, journals, societies, academies, publications and so on. The effort is also made to focus on research groups, networks and significant research projects. The second section discusses the research organization within the institute, facilities provided, promotional and training aspects etc. The final section briefly mentions the rice research technologies and patterns of linkages of research with special reference to varietal development. The Chapter 7 draws our attention to the rice scientists in the laboratories. In this chapter, the case studies conducted at the CRRI, Orissa in India and the RR&DI, Batalagoda in Sri Lanka are discussed. It further gives a picture on the background of the laboratories in brief, significance of rice laboratories in the national context and organization of rice scientists and their productivity in terms of rewards, goal orientation and research climate etc. The environment and the facilities of research laboratories are also discussed. The final Chapter 8 briefly summarizes the contents of the overall thesis and main findings of the study. Apart from underlining the lessons of learning from the study of NARS in India it identifies the issues coming out from the study that needs further research. The chapter also highlights the policy related insights emerging from the study that will have an impact on overall agricultural growth and development in the two countries.