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Characterising rice-based farming systems to identify opportunities for adopting water efficient cultivation methods in Tamil Nadu, India

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A B S T R A C T

Efficient water use in rice cultivation is a prerequisite for sustaining food security for the rice consuming population of India. Novel rice production practices, including water-saving techniques, modifications in transplanting, spacing, weeding and nutrient management, have been developed and shown to be effective on farm, but adoption of these techniques by farmers has remained restricted. Potential constraints include technical difficulties with new practices, and labour and gender issues which differ between farms. On the basis of a rapid survey of 100 rice-based farms, four farm types were identified based on their socio-economic and biophysical characteristics. Detailed farm surveys were conducted on three representative farms of each farm type to evaluate land use patterns, use of inputs such as water, labour, nutrient, capital and machinery, income from crop and animal production and off-farm activities. Opportunities exist for one or more new rice cultivation techniques to be adopted in all the four farm types. For all farm types, however, the opportunities for use of water-saving irrigation were the least promising. In general, adoption of water-saving irrigation will not improve farmers' livelihoods despite its importance in reducing water scarcity problems at regional scale. At farm scale, the potential for adoption of water-saving irrigation depends on the season, location of fields and the irrigation source. zChanges in government policies such as rules and regulations, pricing, institution building and infrastructure development, as well as training and education of farmers are needed to improve the adoption of modified methods for rice cultivation.

1. Introduction

In India, both land and water are becoming binding constraints on farm production as almost 90% of the farmers have less than 2 ha of land, and there is increasing competition for limited water resources. For example, the number of smallholder farmers in Tamil Nadu increased from 4.2 million in the 1970s to 7.4 million by the late 1990s with increasing fragmentation of land (State Planning Commission, 2004). Reliance on rainfall is high, and the poor and erratic rainfall during the monsoons in this semi-arid region leads to moisture deficits for crop production. While farmers may receive irrigation water, they have little control over its availability, as irrigation boards are responsible for the supply. Water availability is further jeopardized because groundwater tables have fallen from 5–10 m below the soil surface two decades ago to almost 60–100 m depth (Public Works Department, 2004). The lack of a controlled supply of irrigation water leads to a high risk of crop failure.

About 70% of the available water for agriculture in Tamil Nadu is used to produce rice (*Oryza sativa* L.), the predominant crop (Thiyagarajan et al., 2003). As irrigation water is available free of charge, farmers tend to minimize the risk of crop failure by over-irrigating their rice crops. This leads to inefficient use of water and low water productivity in rice cultivation.

A series of modified rice production techniques, including water saving, were introduced in Tamil Nadu through testing in on-station and on-farm experiments between 2001 and 2005. The main modifications were to irrigation, planting, weeding, and nutrient management practices (Senthilkumar et al., 2008). On-station experiments gave overall water saving of 40–50% with no reduction in yield and water productivity increased by 40–47% (Thiyagarajan et al., 2002; Senthilkumar et al., 2008). Planting young seedlings in a square pattern combined with mechanical weeding resulted in significant increases in grain yield while application of organic manure led to increased grain yield when

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combined with modified planting and mechanical weeding (Thiyagarajan et al., 2002, 2003; Senthilkumar et al., 2008). Subsequent experiments conducted on 200 farms confirmed that larger yields could be obtained using modified rice cultivation techniques than with current management practices.

Although surveys indicated that the farmers were impressed by the yields and the savings in water use obtained using these novel practices, a number of constraints hampered their widespread adoption. These constraints included problems with irrigation scheduling, the extra labour requirement for square planting and a shift from women's labour for hand weeding to men's labour for mechanical weeding (Senthilkumar et al., 2008).

A comprehensive understanding of the characteristics that determine farm structure and functioning is needed to understand the factors that determine adoption. As each farm household is unique and future options cannot be explored for each individual farm there is a need to categorise them. Farm types can be inferred based on their characteristics using multivariate analysis and clustering techniques (Duvernoy, 2000). Farms have been grouped based on criteria such as size of land holding (Duvernoy, 2000), area of the various crops and the availability of labour and equipment (Leenhardt and Lemaire, 2002) and survival strategies (Daskalopoulou and Petrou, 2002). Tittonell et al. (2005) classified farm types using socio-economic information, production activities, household objectives and the main constraints faced by farmers. In other studies, farms have been classified based on characteristics and rates of structural change to analyse differences in agricultural trajectories (Iraizoz et al., 2007), or using the relative distribution of the farm income from production activities (field crops, dairy cattle, etc.) (Andersen et al., 2007).

In this study, we categorised farms based on resource endowments, i.e. quantifiable biophysical (e.g. land, labour and water availability) and socio-economic (e.g. education, wealth) characteristics of the family and their farm. Our objectives were to: (1) understand the farm structure and functioning; (2) determine the degree of adoption of novel rice cultivation practices; and (3) assess the opportunities and constraints for different types of farmers regarding the adoption of these practices in future.

2. Materials and methods

2.1. Farm typology

A rapid farm survey was conducted on rice-based farms in the Thamirabarani river basin in the southern part of Tamil Nadu, India. The river starts in the Western Ghats and ends in the Bay of Bengal, and the basin lies between 8°45′and 9°23′ latitude and 75°13′and 77°54′ longitude. One hundred farms were selected to represent the rice-based farms situated in both the catchment area where no irrigation water is received from the river and in the command area that receives irrigation water (Fig. 1). Overall 43% of the farms in the river basin are rice-based, above the state average of 34% (Statistical Hand Book, 2006). Farms were selected by asking the village head and local people to identify farmers who cultivate at least one rice crop per year. Since one of the objectives of this study was to explore adoption of novel practices in rice cultivation, 35 of the 100 farms surveyed were randomly selected from the group that had participated earlier in on-farm experiments. The other farms were randomly selected among the farmers that grew rice but had not participated in earlier experiments. The steps followed in the farm surveys, selection of farms, data collection and analysis are summarised in Fig. 2.

A questionnaire used to generate a typology of farms in western Kenya (Tittonell, 2003) was modified for this study. Information was obtained on farm size and the number of rice crops each year, farm family characteristics including age and main occupation of the farmer, total household members, education level of the farmer and his family, and farm wealth. Family labour availability was

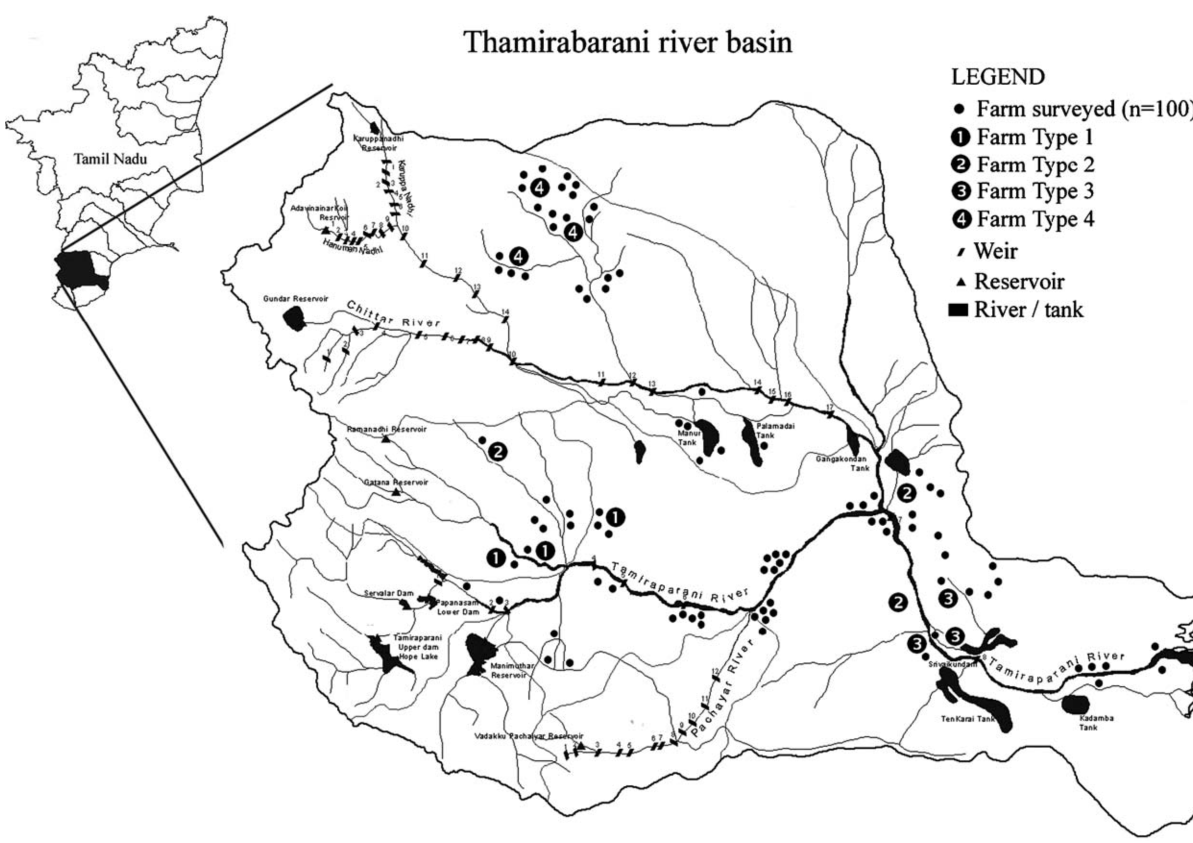

Fig. 1. Location of Thamirabarani river basin in Tamil Nadu, India. The farms surveyed (n = 100) and sample farms (n = 3 per farm type) for detailed survey are indicated.