Role of Knowledge Inequality and Social Entrepreneurship in Agricultural Transformation: Case of Rural South India

Suresh Chandra Babu
International Food Policy Research Institute, Washington DC, USA

C. Jayachandran
Montclair State University, New Jersey, USA

Abstract

The importance of knowledge and social entrepreneurship in agriculture is well understood, but little is done to reduce this skill gap among smallholders. This paper studies the role of knowledge inequality and social entrepreneurship in agricultural transformation using the case study of System of Rice Intensification (SRI) in South India. We show how adoption of innovation is strongly dependent on the level of knowledge inequality, which in turn is driven by the entrepreneurial capacity of farmers and the level of resource use in society. With primary data from households and through focus group discussions, our analysis shows that knowledge inequality and social entrepreneurship are key factors contributing to productivity differences among farmers, especially when new technologies and techniques need to be adopted. We establish links between knowledge inequality and social entrepreneurship and conclude that for agricultural transformation policymakers need to first increase capacity for social entrepreneurship and then focus on knowledge equality.

Keywords: Agricultural transformation, resource use, knowledge inequality, social entrepreneurship, South India

1. Introduction

Economic growth of nations is driven by the productivity of various sectors of their economies. Productivity levels in turn depend on the knowledge and skills of production agents in each sector. In fact, the basic inputs for any production process is knowledge and skills for application of that knowledge (Luttmer, 2014). Agriculture is becoming an increasingly knowledge-intensive activity, both in developed and developing countries. Starting from production to distribution, context specific knowledge is essential for farmers to make optimal decisions. Farmers acquire knowledge through various sources, such as, government extension workers, NGOs, ICT applications, private extension providers, and other progressive farmers. However, despite availability of multiple sources of information, some farmers have access to more knowledge and skills than others do. This could be due to differential access to better connection, higher education, or greater ability to pay for knowledge services. The resource-constrained farmers of developing countries usually have limited access to sources of knowledge. This is reflected in the challenges to achieve Sustainable Development Goals of zero hunger and poverty by 2030 that highlight the low productivity and poor management of natural resources as major issues faced by smallholder farmers in developing countries (UNDP, 2015). Increasing ability of smallholder farmers to obtain and use knowledge related to production techniques, marketing, and processing has been suggested as a means of increasing productivity. This approach is meant to enable every farmer to achieve maximum production levels in a given set of farming and resource conditions. Reducing the knowledge inequality among farmers depends on matching the knowledge gaps by identifying the knowledge needs that are context and agro-ecology specific (Anderson and Feder, 2004). Despite the importance of reducing knowledge inequality, very little is known about the knowledge base of farmers and how effectively this could be used to reduce the knowledge inequality among the farming community (Swanson and Rajalathi, 2010). The analysis presented in this paper is a step in this direction.

Similarly, there is also a need to improve the capacity for social entrepreneurship in resource constrained societies. Social entrepreneurs are "individuals with business acumen who are on a social mission and can provide the new approaches needed to hasten the process of reaching desired policy outcomes" (Babu and Anderson, 2007). We argue that combining innovative ideas from individuals with investments from public, private, and civil society organizations, social entrepreneurs can guide complex policy systems and institutions towards desired goals.

The study of knowledge inequality and social entrepreneurship in the context of agricultural transformation requires addressing the following fundamental questions: How do farmers acquire information and convert it into a useful knowledge base for production and business processes? Who are the players and actors in the information value chains? What constraints and challenges do these actors face in sharing knowledge? What mechanisms - public, private, NGOs, and farmer-to-farmer exist in strengthening the process of knowledge sharing at the community and individual levels? How does one measure knowledge inequality and social entrepreneurship in the context of technological innovation? What policies and programs need to be in place to reduce the knowledge inequality? What is the role of social entrepreneurs in reducing knowledge inequality? Addressing these questions, this paper develops a boarder conceptual framework and uses it to help in the process of reducing knowledge inequality. Further, the paper also explores the links between knowledge inequality in societies and social entrepreneurship.

The objective of this paper is to identify the factors responsible for the knowledge inequality in the rural community and its implications on agricultural transformation. We find that along with knowledge inequality, it is important to increase resource use and entrepreneurial capacity of farmers for agricultural transformation. Focusing on the role of farmers as social entrepreneurs, this paper shows that improving business orientation and entrepreneurial skills of farmers can reduce knowledge inequality, hence improving their incomes and livelihoods. Using the case of farmers apply the System of Rice Intensification (SRI) technique in the South Indian state of Tamil Nadu, the paper draws its results from focus group discussions, selected farmer interviews, and farm level surveys.

The rest of the paper is organized as follows: the next section develops a conceptual framework for studying knowledge flow and accumulation in agrarian economies. Section three gives a background on the case and the data and methodology used. Section four presents the results in the context of technology adoption under the SRI, and finally section five provides the concluding remarks.

2. Conceptual Framework

This section presents the conceptual framework used as a basis for the analysis presented in this paper. Agricultural transformation occurs when available knowledge is accessed, applied, and aligned to action on the ground. Actions depend on translating existing knowledge, which further depends on the individual, institutional and system level capacities that convert knowledge to action. However, access to knowledge by institutions and delivery systems is also constrained by the knowledge base. Social scientists have explored how knowledge is generated, absorbed and used for productive purposes for quite some time (Mittal et al., 2010). The role of knowledge in agricultural production and entrepreneurial activities is well recognized. In most developing countries, public extension systems remain the main source of knowledge for farmers. However, there is a growing effort to shift towards more pluralistic extension systems to increase the knowledge content and its effective use by the farmers (Davis et al. 2012). Following Arrow (1962), several studies have developed theoretical and empirical approaches to learning and knowledge accumulation among productive economic agents (Hanna et al, 2014; Gomes et al, 2016). Recently, knowledge sharing through the formation of social capital have been given importance in the development literature. Putnam (1993) and other researchers have attempted to model the factors that contribute to accumulation of social capital (Glaeser et al., 2002; Aldrich and Meyer, 2015). The level of social capital of economic agents, and the variation in their levels of social networking could explain the distinct knowledge inequality and inconsistencies their entrepreneurial ability. Farmers, just as any other group of economic agents, differ in their ability to access and use knowledge in the production process. Their access to information and ability to transform such information into knowledge towards, production, processing, and marketing of agricultural produce depends on several factors: their age, education, experience in farming, their financial status, type of farm enterprise and distance to other knowledge farmers (Babu et al, 2012).

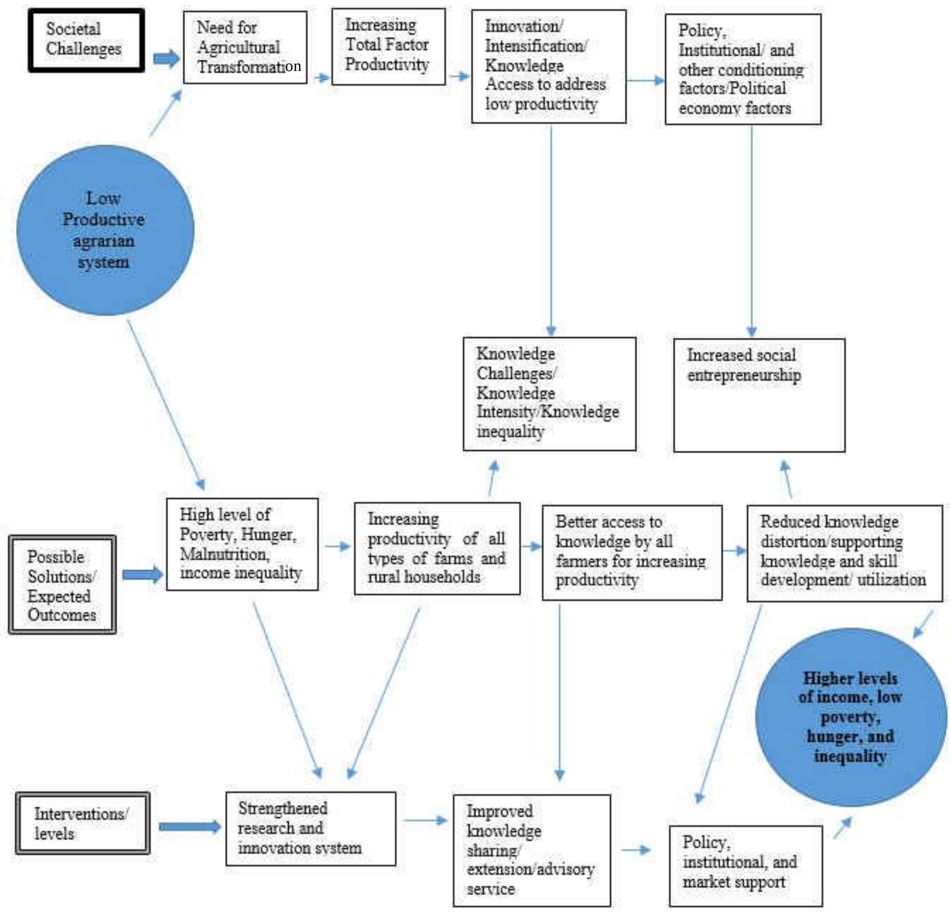
With the rapid emergence of new production technologies, knowledge and information are increasingly becoming the most important inputs of agricultural production. The intensity of knowledge use increases with need for the making agriculture more business-oriented. Policymakers in India face several challenges in increasing food production to meet the needs of its growing population. First, given the scarcity of land and water resources increasing crop productivity becomes a major imperative. In the context of rice cultivation for example, there is a call for increasing the average yield of rice from the current 2.5 tons per hectare to 5 tons per hectare. Second, the use of natural resources such as irrigation water must be made more sustainable. This calls for water conservation technologies to be included in all cropping systems particularly in the rice and wheat production systems where water is used inefficiently due to flooding system of irrigation. In addition, due to poor quality and unreliable supply of free electricity to rural areas, the pumping of ground water has been unsustainable. Third, there is a need to reduce the cost of cultivation by optimizing the use of inputs such as labor, fertilizer, plant protection chemicals, and seeds. Fourth, by improving the quality of harvested yields through quality control and improved storage methods, famers could benefit from the increased profitability of crop production. Fifth, by increasing the prudent use of chemical inputs, environmental contamination from agriculture and the associated health risks could be reduced. Finally, increasing the transformation of agricultural sector from a subsistence-orientation to business-orientation requires the expansion of the knowledge base of farmers in rural entrepreneurship. In the context of rice production, SRI provides an opportunity to achieve these objectives. In this paper, we use SRI as a case study to explore the knowledge needs, gaps, and inequality and its effects on the entrepreneurship of smallholder farmers in rural south India. Further, we study the role of social entrepreneurship in reducing this knowledge inequality.

Before moving to the conceptual framework, it is important to note that there are three broad kind of social entrepreneurs, namely, policy entrepreneurs, business entrepreneurs, and program entrepreneurs (Babu and Anderson, 2007). Policy entrepreneurs are well versed in policy processes needed to expand successful local programs into large-scale national programs with a wider poverty impact. Business entrepreneurs apply the principles of business development to social problems which could be another way of solving the challenges of poverty and hunger in developing countries. Program entrepreneurs are instrumental in designing and implementing innovative programs to reduce poverty and hunger funded by development partners, national governments, and nongovernmental organizations (NGOs). Each type of entrepreneur can play a dominant role at different stages of the policy process. While all social entrepreneurs need to remain engaged throughout the policy cycle, their ability to exercise influence on the outcome changes at every stage. Hence, these entrepreneurs are better off in ensuring full engagement at different stages of the policy process. We focus on farmers as agents of change, in this paper, and show how social entrepreneurship can help in reducing knowledge inequality.

The conceptual framework presented in Figure 1 shows how knowledge inequality affects the productivity of farmers. This process begins with societal challenges such as high level of poverty and hunger, characteristic of rural agrarian societies in developing countries. Agrarian systems with low levels of productivity could be transformed into highly productive systems through the effective use of knowledge. The first row highlights the societal challenges and the need to increase the total factors productivity of farming systems. The second row identifies a set of possible solutions and corresponding expected outcomes. The third row shows the levels and results of interventions. Collectively these factors and interventions move an unproductive agrarian system to a higher level of productivity resulting in higher incomes for farmers and better standards of living. Moving along the first row, increasing total factor productivity will require bringing all types of farms up to a higher productivity frontier. This can be achieved by strengthening the research and innovation system at the national level with a strong focus on social entrepreneurship. Innovations, intensification, and knowledge access depend on the extension and rural advisory services realigning their focus. This requires understanding of the knowledge challenges, the required knowledge intensity and the current levels of knowledge inequality in the specific context. Addressing these gaps through policy, institutional, and market support can reduce knowledge distortion among farmers and increase their productivity. To develop effective policies and programs that will increase the farmers' access to information and reduce knowledge inequality among them, factors associated with farmer's behavior to search and use knowledge, needs to be fully understood.

In what follows, we apply this conceptual framework to SRI in rural South India to explore the issues, constraints, and challenges farmers face in the access and use of knowledge to increase their productivity.

Figure 1: Knowledge Inequality and Its Role in Agricultural Transformation



3. Case Study: System of Rice Intensification in Rural South India

To understand the role of knowledge inequality in agricultural transformation, we use a major technological innovation in rice production introduced in the last 15 years in several parts of the developing world – the SRI. SRI is a unique traditional approach to increase rice productivity. It is traditional because it does not require the use of new seed varieties. While SRI remains controversial among scientists and extension workers, its adoption continues to increase. However, in some areas farmers have been observed to abandon the innovation after trying for a few years. Knowledge inequality among the farmers is hypothesized in this paper as a major cause for such "adopt-abandon" roller-coaster phenomenon of technological innovation. We do not attempt to evaluate the technological impact of this innovation, but use SRI to understand the constraints to technological and innovation adoption mainly arising from the unequal distribution of knowledge. We begin by examining the information needs of farmers as a major entry point to this analysis. Results of a recent survey (Babu et al., 2012) on the information needs, their importance, and access reveals that much of the knowledge base needed for SRI falls in the average importance and access. This could partially explain the adoption challenge faced by SRI. Other information needs and SRI-related information also falls under neutral or below in the level of importance. However, the information needs analysis presented in Babu et al. (2012) does not specifically address the package of practices identified and promoted under SRI adoption. We look at these in the context of knowledge inequality below. Innovation is crucial to increasing the productivity of rice farming systems. We choose SRI to study the interaction among knowledge intensification, knowledge inequality and entrepreneurship, all of which are needed for any agricultural transformation process.

Knowledge required by farmers is context specific and depends heavily of the prevailing agro-economic conditions. Farmers' access to knowledge can be determined based on the specific set of activities involved during the production cycle or along their commodity value chains (Ali and Kumar, 2011). This study uses a variety of qualitative methods to understand knowledge access behaviors of farmers. As part of this study, we conduct 27 focus group discussions (FGDs) between March and May 2011 to reach our results. In January 2014, we conducted FGDs based on knowledge levels on SRI, in five focused clusters to further inform our findings. The FGDs were carried out in randomly selected villages. In addition, several key informants were interviewed including researchers from agricultural universities, extension workers, and other officials of the state department of agriculture. For more details on the methodology please refer to Glendenning et al (2010) and Babu et al (2012). Next, we present the findings obtained from the qualitative data collected through these FGDs and interviews.

4. Results and Discussion

In this section, based on the expert consultation with the research committee, extension officials, and farmer focus group discussion we bring out the salient characteristics of technological innovations and how such innovations introduce inequality of adoption knowledge. The characteristics that are analyzed here are knowledge intensity, resource use intensity, and entrepreneurial intensity. These are important indicators that determine the productive capacity of farmers.

4.1 Knowledge Intensity of Technological Innovations

Knowledge intensity reflects the level of knowledge required for the use of a technological innovation. Table 1 presents the principles and practice of SRI technology along with the knowledge challenges and knowledge intensity as identified during the expert and focus group discussions. The results presented in the last column of the table have been drawn from the focus group discussions conducted.

Table 1: The System of Rice Intensification: Principles, practices, and knowledge intensity

Principle of SRI	Actual practice	Knowledge Challenge	Knowledge intensity (rated between 1-5)
Very young seedlings should be used, to preserve the plant's inherent growth potential for rooting and tilling	8 – 15 day old seedlings with 3 leaves are grown in a raised-bed nursery	Moving from traditional broadcast method of nursery beds to row sowing of seeds	Farmers need to closely manage the seedlings. We find that raised nursery bed, maintenance of single seedlings, and keeping track of age of the nursery requires knowledge intensity of 3
Transplanting single seedling per hill should be done quickly, carefully, shallow and skilfully, in order to avoid any trauma to the roots, which are the key to plants' success	Single seedlings are planted with a minimum time interval between the time they are taken out from the nursery and planted carefully at a shallow depth (1-2 cm)	Teaching farm labours about trauma free transplanting requires knowledge of skills transfer at farm lead farmers need to train their labour force	Nursery needs to be raised next to main field, multiple nurseries needed to avoid time delay, high skilled labour force to maintain the depth of planting requires knowledge intensity of 4
Reduce the plant population radically by spacing hills widely and squarely, so that both the roots and canopy have room to grow and can have greater access to nutrients, sunlight, etc.	Planting at grids of either 20 x 20 cm or 25 x 25 cm (or 30 x 30 cm or even wider if the soil is very fertile) using a rope or roller marker to achieve precise inter-plant distances (to facilitate inter-cultivation)	Change from random approximate bunchy planting to single seedling planting with precise grid distance maintenance	Knowing which type of soil requires what type of grid sparing; maintenance of row spacing for inter-cultivation requires more labour and skill guided by supervision, require knowledge intensity of 3
Provide growing plants with sufficient water to meet the needs of roots, shoots and soil biota, but never in excess, so that the roots do not suffocate and degenerate	Up to panicle initiation: Irrigate to 2.5 cm depth after the water ponded earlier disappears and hair-line cracks are formed on the soil surface. (Heavy clay soils should not be permitted to reach the cracking stage, but still are issued less water than with usual flooding.) After panicle initiation: Irrigate to a depth of 2.5 cm one day after the water ponded earlier disappears.	Gracing the soil moisture and water required by farmer/ labours, control of water movement among farmers varying sowing and planting dates, constant monitoring of water levels in the flooded zones, uncertainty of rainfall, electricity availability labour availability reduces water control	Knowledge on water needs is different cropping stages, measuring moisture levels to protect crop from wilting and from over irrigation is simply not part of extension or farm level 4 practice. This is not only new but the adoption of water management as prescribed by SRI is considered high knowledge intensity activity at (4)
Active soil aeration improves rice crop growth by benefiting both roots and beneficial aerobic soil organisms.	Inter-cultivation with a mechanical weeder at intervals of 10-12 days starting after transplanting and continuing until the canopy closes, passing between the rows, and making perpendicular passes across the field.	Knowledge and use of mechanical weeder, interaction of weeds and crop depends on the level of water. Effective use of mechanical weeder depend on the soil and water properties	Weeding and weed management is an additional requirement that is a result of principle 4 recommended above weeding is also recommended as a practice that can help in soil aeration. This is again high knowledge intensive activity since usually weeds are killed in the traditional system by submerging them under water (4)
Augmenting organic matter in soils, as much as possible, improves performance of the rice crop, by improving soil structure and functioning and supporting beneficial soil organisms.	Application of cattle manure, green manure, bio-fertilizers, and vermi-compost is recommended. Chemical fertilizer can be used, but it does not have the same beneficial effects on soil systems.	More than knowledge, availability of biomass for organic names is a constraint; production requires additional farming chemical fertilizers/ organic resources substitution requires soil testing and knowledge to use soil-testing results.	Knowledge of what to apply as nutrients and in what form requires understanding of what is a in the soil. Soil testing infrastructure remains poor. Even if the results are available recommendations and known, availability of inputs in time is critical for effective use of knowledge. Farmers are 5 at most disadvantage when using optional level of nutrient, leave alone the right combination of organic and inorganic fertilizers

Source: Columns 1 and 2 directly taken from SRI brochures (Uphoff, 2011)

Although SRI brings in additional knowledge for crop intensification, the traditional package of practices that farmers normally implement still hold for SRI. For example, researchers say the initial preparation of land, selecting the right variety of seed for the agro ecological zones and water and soil conditions, seed treatment, and other plant protection measures are still to be adopted to the highest standards as recommended. SRI brings additional agronomic efficiency. However, the key question to the research and extension community is - at what cost? For example, in preparation of the nursery, farmers are asked to plant the seeds in rows so that individual seedling could be pulled out for transplanting. This is a major shift in the way the nursery is normally raised and requires significant level of knowledge. Transplanting using single seedling per hill increases the labor needs. But more importantly the need for extension personnel to educate the laborers who transplant rice seedling, who are mostly women, increases multifold. Due to deterioration of public extension services, the number of farmers reached out by extension agents have dramatically reduced. During this period of decline, more than 50 percent of farmers reported not to have met an extension agent in the previous year (NSSO, 2005). The skills needed for a single seedling planting on the grid require a high knowledge intensity and pose a formidable knowledge challenge for the extension workers, farmers, and farm laborers.

The knowledge intensity of water management (a key SRI principle related resources conservation) is further compounded by other resource use challenges. For example, depth of water to be maintained in the rice fields is not within the control of individual farmers. In addition, farmers lack the skills to measure the depth of water stagnation in the rice fields. Since the farm laborers are not used to managing water depth of individual farms this principle requires high knowledge intensity at all levels of knowledge value chain.

The principle of soil aeration creates a similar knowledge challenge. In the focus group discussion, there was some confusion among farmers on this principle. The practice was often confused with weed management as both activities require a high level of skill and labor. Farmers in the study area reported that they would prefer to submerge their fields to control weeds. Farmers reported that SRI increases the need for chemical application of weedicides to control weeds. This increases the knowledge requirement further as a wide range of weedicides are promoted by the chemical companies and farmers, due to low access to extension system, are under the mercy of the input dealers. To make matters worse, these dealers often push the chemicals that are in stock at the time farmers require them, not necessarily the chemicals appropriate for the activity. In fact, one expert claimed that the chemical companies promoted use of chemical weedicides under labor-scarce conditions. In addition to the added requirement of weedicide knowledge, farmers who have access to laborers have to educate them in the use of the mechanical weeder. The manufacturers of the weeder have not been fully responsive to the needs and low physical ability of farm laborers. Even with the Government of Tamil Nadu providing subsidy to adopt the mechanical weeder, most farmers consulted said that they have abandoned its use.

Application of organic matter to rice production is promoted as a principle under SRI. This traditional practice followed by farmers has been under low level of adoption ever since the advent of chemical fertilizers introduced intensively during the green revolution of the 1970s and 1980s. Since then the ease of obtaining subsidized fertilizers reduced the need for organic manure application and due to increased level of mechanization, the livestock population and the availability of animal manure for fertilizer use has declined. The organic matter found in green manure could only be applied when grown between seasons and in-situ ploughed in. Yet due to poor soil testing infrastructure, the optimal combination of organic and inorganic levels of fertilizer use remains a major knowledge challenge for the farmers. Thus, farmers report to use the traditional approach of blanket application of NPK nutrients.

In summary, our focus group discussions reveal that SRI is a knowledge intensive technique and requires a continuous supply of resources throughout the production process. Additionally, for some SRI principles, there is a need to ensure that the correct resources are available at the right time for farmers. To ensure that farmers do not end up dropping the use of SRI, farmers' needs at each stage the production process need to be considered. Detailed results are presented in the Table 1.

4.2 Entrepreneurship and Knowledge Intensity

In this section, we study how knowledge intensity and entrepreneurial capacity of productive agents interact with each other, in the context of a technological innovation. Table 2 presents the detailed results of our analysis. The results presented in the last column of the table have been drawn from the focus group discussions conducted.

Table 2: Interaction of Knowledge and Entrepreneurial intensities under the System of Rice Intensification

Principle of SRI	Entrepreneurial need	Entrepreneurial challenge	Entrepreneurial use intensity	Implication / Interaction with Knowledge Intensity
Young seedling	Common/ collective nursery requires bringing farmers together/ for collective action	Investment for the whole community or village level requires investment upfront which is not often available	Mobilizing labour and bargaining for improving their skill without increasing the labour cost requires extra entrepreneurship skills	Developing highly skilled labour without cost increase remains a challenge. Support to train labourers on a collective basis requires public extension support which is missing currently
Single seedling per hill	Mobilizing labour during the peak transplanting period competes with traditional planting	Farmers are often not trained in collective action or negotiating labour groups for transplanting rice is an entrepreneurial challenge	Quantity of labour needed is less but negotiating to access quality and skilled labour increase entrepreneurial intensity	Poor entrepreneurial skills thwart effective use of knowledge gained by farmers. Knowledge transfer to labourer requires supervisory intermediaries
Planting in square grids	Hiring labour and supervising them	Negotiating with labour groups	Impart high skills year after year	Knowledge transfer is highly engaging and need hiring of extension staff which farmers cannot afford
Water management	High entrepreneurial need for negotiating with neighbouring farmers water harvesting and marketing water culturing farmers do not pay for water	Culturally farmers do not pay for water given by neighbouring farmers. Creating market for resource use and management remains	Managing water resource has implication for other package of practice recommended	Forming and operating water user associations hiring water management expertise and negotiation water use with neighbours all increase entrepreneurial intensity and highly sensitive to the differing knowledge of the farmers
Weed management and inter-cultivation	Organizing labour for weeding negotiating for weedicide application requires entrepreneurship	Dealing with input suppliers and managing the quality of weedicides that are applied to the field when there is competing suppliers	Organizing local artisans for manufacturing weeder suitable for local soil increase intensity of entrepreneurship. In either case making optional soil fertility management choices requires high level of recourse use skills	Weeding, improving the aeration of soil and other inter-cultivation of operations further increase the need for organizing labour and building their skill. Interacting with input dealers who often sell spurious chemicals increase the cost for the farmers
Soil fertility management through increased use of organic manure	Some farmers have taken up production of vermi-compost to meet this technical requirement. Production and marketing organic measures could be a profitable activity if SRI is adopted in large scale	Availability of animal manure which competes with fuel making for cow dung cake/ and the technology and investment farmers need to make vermi-compost increase the entrepreneurial challenge	Farmers have to mobilize adequate quantities of organic manure during the land preparation period, which requires collective action. Increasing the number of entrepreneurs who can supply organic manure will be effective	Lack of entrepreneurs to supply organic manure to farmers, indicates high entrepreneurial intensity involved

Source: Columns 1 and 2 directly taken from SRI brochures (Uphoff, 2011)

We find that farmers who, continue to adopt SRI despite the knowledge and resources challenges, tend to have higher level of entrepreneurial and managerial ability. In addition, higher social networking with the labor groups, input providers, local water management associations, and with public extension workers tend to increase the adoption rate and continued the adoption of SRI. Table 2 summarizes the interrelations of knowledge and entrepreneurial intensities in the adoption of SRI. As shown by the discussions, entrepreneurial and social management skills could help in better adoption of SRI among farmers. Farmers who see their farming as a business enterprise are likely to seek more support from various sources to reach higher productivity of rice that is possible under SRI approach. Yet for the average smallholder farmers who own less than five hectares of land and farmers who see rice cultivation as more of a “way of life” and therefore, additional efforts to increase their entrepreneurial and management skills may not be worthwhile.

Further, SRI introduces new entrepreneurial challenges to the traditional farming system. For example, production of seedlings in a cost-effective manner requires collective action at the village level. However, collective action also requires convincing other farmers in the village to adopt the SRI approach. This is a challenge since not all farmers are willing to jump in early and SRI adoption essentially depends on the “seeing is believing” approach. Mobilization of skilled labor at various stages of crop production particularly at the time of transporting and weeding require high level of negotiating skills mainly due to labor scarcity that prevails in the study area. Addressing labor scarcity through mechanical means requires collective action and investment from few farmers to purchase, maintain, and manage the transplanting machine. Thus, an innovation such as SRI, needs additional investment in improving social entrepreneurship for effective use of knowledge and application.

4.3 The Resource Use Intensity of Technological Innovation

The resource use intensity reflects the resources production agents require to adopt a particular technological innovation. Table 3 presents the resource needs arising from SRI adoption. This includes, the resource challenges traced by the farmers in adopting each SRI principle, the resource use intensity, and its interaction with knowledge intensity. The results presented in the last column of the table have been drawn from the focus group discussions.

The data compiled based on the focused group discussions with farmers and experts involved in SRI promotion, have implications for the “adoption/abandon” process seen in the study area. While SRI adoption reduced seed rate, cost of seeds, and the number of seedling needed, the labor resources needed for planting in square grids and the associated supervision costs takes away this saving from the farmers. In addition, water management, weed management and inter-cultivation operations along with the organic matter build up recommended under SRI requires additional labor and other resources. Collectively these additional set of resources place higher level of resource use challenges than traditional farming practices. Further, labor shortages have increased due to the government policy that requires the guarantee of 100 days of assured employment to anyone needing a job in rural areas. This has presented enormous challenges to the adopters of SRI. Farmers of the study area generally refer to SRI as a labor- and management-intensive innovation, the perceived cost of which outweigh the increased yields. There was generally no negative reaction on the potential and real benefits of SRI when it is fully adopted.

The resource challenges associated with SRI arise not only from the quantity of available labor but the required quality and skills as well. The increased resource use intensity exists at every SRI principle (see Column 4, Table 3). Thus, even when knowledge is fully accessible to every farmer at the same level, which is still a basic challenge due to poor organization of the public extension system, a high degree of resource use intensity may prevent farmers from fully adopting the SRI. When the agronomic practices are not fully followed, as suggested by the SRI package, the benefits to farmers may not be significantly different from a farmer say, who follows less resources intensive traditional package of practices. Farmers of the study group reported that the hurdles in obtaining labor needed throughout the crop season and in increasing the quality of such labor, largely prevent them from continuing production under the SRI method even if it has been adopted for one or two years. One farmer said, “I am willing to train my labor force one year in the details of SRI, but since there is no guarantee that I would get the same labor next year, I have to train the laborers every crop season which becomes highly time consuming and may not be rewarding”. In summary, we find that knowledge intensity and the resources use intensity combined produce high level of knowledge inequality among the farmers which result in the eventual abandonment of SRI method in the study area.

In summary, our focus group discussions reveal that farmers face a number of constraints in following SRI practices in the long run. This is because SRI is knowledge intensive and requires a steady investment of skills and resources throughout the production process. The FGDs reveal that farmers are often constrained on multiple dimensions and are not able follow SRI principles consistently in the long run. Some of the key constraints farmers face are: shortage in labor supply, low capacity for collective action, inadequate extension provision, and untimely availability of resources. Reducing knowledge inequality, improving resource use, and enhancing social entrepreneurship will go a long way in helping farmers overcome these constraints.

5. Conclusion

Agricultural transformation requires optimal uptake of technology by productive agents, which is dependent on application of knowledge by all levels of society. In this paper, we develop a framework to understand how the nature of innovation for agricultural transformation and factors influencing its uptake interact with knowledge inequality. We use the case of SRI application in South India to understand our hypothesis. The key lessons that can be drawn from our analysis are presented along with the concluding remarks in this section.

We find that knowledge inequality plays a key role in slowing the process of agricultural transformation. Our analysis indicates that policy, institutional, and market interventions are needed to reduce knowledge inequality. Governments must make an active effort on developing capacity for continuously identifying and filling knowledge gaps at all levels.

The results also indicate that with high intensity of knowledge needs and high inequality of human capital, there is greater likelihood for inequality of knowledge to increase. Knowledge sharing and distribution mechanisms determine the level of inequality of knowledge among productive agents. There is a need to ensure that governments create enough platforms and avenues for knowledge sharing and distribution.

Knowledge inequality increases with knowledge distortions due to mismatch of policy and institutional interventions. Further, with low incentive for collective action at the village level, these distortions increase. There is a need to coordinate policies that aim to reduce knowledge inequalities and encourage participation in knowledge sharing at the village level.

We find that increasing capacity for social entrepreneurship, by transforming farmers into agents of change reduces their vulnerability. Entrepreneurial farmers are more likely to obtain optimal productivity outcomes due to factors such as, negotiation skills, ability to seek out for technical assistance, and capacity for collective action.

Finally, along with knowledge and entrepreneurial intensities, resource use intensities of farmers need to be addressed for effective translation of knowledge into production activities. Addressing knowledge inequalities and social entrepreneurship are not sufficient for agricultural transformation. Efforts to build resource use and entrepreneurial capacity alongside is also important.

References

Aldrich, D & Meyer, M 2015, "Social capital and community resilience," *American Behavioral Scientist*, 59, 2, pp. 254-269.

Ali, J., & Kumar, S 2011, "Information and communication technologies (ICTs) and farmers decision-making across the agricultural supply chain," *International Journal of Information Management,* 31, 2, pp. 149-159.

Anderson, J & Feder, G 2004, "Agricultural extension: Good intentions and hard realities," *World Bank Research Observer,* 19, 1, pp. 41-60.

Arrow, K 1962, "The economic implications of learning by doing," *Review of Economic Studies*, 29, 3, pp. 155-73.

Babu, S, Claire J, Asenso-Okyere, K & Govindarajan, S 2012, "Farmers' information needs and search behaviors: Case study in Tamil Nadu, India," *IFPRI Discussion Paper No. 1165*. Washington, D.C.

Davis, K, Nkonya, E, Kato, E, Mekonnen, D, Odendo, M, Miiro, R, & Nkuba, J 2012, "Impact of farmer field schools on agricultural productivity and poverty in East Africa," *World Development*, 40, 2, pp. 402- 413.

Glaeser, E, Laibson, D, & Sacerdote, B 2002, "An economic approach to social capital," *The Economic Journal*, 112, 438, pp. F347–F458.

Glendenning, C, Babu, S, & Asenso-Okyere, K, 2010, "Review of Agricultural Extension in India: Are farmers' information needs being met," *IFPRI Discussion Paper No. 01048*. Washington, D.C.

Gomes, R, Gottlieb, D, & Maestri, L 2016, "Experimentation and project selection: Screening and learning," *Games and Economic Behavior*, 96, pp.145-169.

Hanna, R, Mullainathan, S & Schwartzstein, J 2014, "Learning through noticing: Theory and evidence from a field experiment," *The Quarterly Journal of Economics*, 129, 3, pp.1311-1353.

Luttmer, E 2014, "Knowledge diffusion, growth, and inequality," University of Minnesota, Working Paper (forthcoming).

Mittal, S, Gandhi, S & Tripathi, G 2010, "Socio-economic impact of mobile phones on Indian agriculture," Working Paper No. 246. *Indian Council for Research on International Economic Relations*. Delhi, India.

NSSO (National Sample Survey Organisation) 2005, *Situation assessment survey of farmers: Access to modern technology for farming, 59th round (January–December 2003*," Report No. 499(59/33/2). New Delhi: Ministry of Statistics and Programme Implementation.

Putnam, R 1993, *Making democracy work: Civic traditions in modern Italy,* Princeton University Press, Princeton.

Ray, D 2006, “Aspirations, poverty, and economic change,” In Banerjee, A, Bénabou, R & Mookherjee, D, eds., *Understanding poverty,* Oxford University Press, Oxford.

Swanson, B & Rajalahti, R 2010, *Strengthening agricultural extension and advisory systems: Procedures for assessing, transforming, and evaluating extension systems, agricultural and rural development*, Discussion Paper No. 45. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/23993 License: CC BY 3.0 IGO.”

UNDP 2015, *Transforming our world: The 2030 Agenda for Sustainable Development. United Nations Conference on Sustainable Development. Rio de Janeiro, Brazil*, Retrieved from http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E.

Uphoff, N 2011, “The System of Rice Intensification: An alternative civil society innovation’, *Technology Assessment: Theory and Practice*, 20, 2, pp. 45-51.