INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

IFPRI

December 2011

Farmers' information needs and search behaviors: Case study in Tamil Nadu, India

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Acknowledgements

This paper emanated from a project funded by IKP Trust of India to whom we are grateful.

Acronyms

AO	agricultural officer
AAO	assistant agricultural officer
APL	Above poverty level
BPL	Below poverty level
FBO	Farmer based organization
FGD	Focus group discussion
ICT	Information and communication technology
IKSL	IFFCO Kisan Sanchar Limited
KCC	Kisan Call Centre
PACB	Primary agricultural cooperative bank
RML	Reuters Market Light
SC/ST	scheduled caste/scheduled tribe
SRI	System for Rice Intensification
VAO	Village administrative officer

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Abstract

Public agricultural extension systems often fail due to inadequate consultation of farmers about their information needs and poor understanding of their information search strategies. In discussing and implementing extension programs and advisory services, the following questions need to be addressed: What information do the farmers need? How and where do they search for information? What factors determine their search behavior? How much are they willing to pay for their information? While the first two sets of questions are addressed fairly well in the literature, the latter two have not yet been attempted in the context of developing countries. Using a case study of two districts in South India, we examine farmer information needs and their information search behavior, factors affecting their search behavior, and their willingness to pay for information. Cluster analysis on access, frequency and use of information sources identified four farmer information search behaviors – high, medium, semi-medium and low. The groups differed significantly by post-high school studies, household economic status, cultivated land area, agricultural income, and membership to a farmer-based organization (FBO) and a Primary Agricultural Cooperative Bank (PACB). We use these four information search behaviors to examine differences in information needs, sources used and preferred sources. The important information needs related to rice included pest and disease management, pesticide and fertilizer application, seed variety, seed treatment. Rice production practices and credit information was more important for the low search group. Private input dealers and the state department of agricultural extension staff were the main information sources, though use of these two sources decreased with greater information searching. High and medium searchers used a greater number of sources, which also included print media and TV. The major constraints to information access, common to all search groups, were poor reliability and timeliness. The preferred medium of information was interpersonal contacts followed by information via mobile phones, where a helpline or voice messages was preferred over SMS. Through a contingent valuation technique it was found that farmers' willingness to pay for voice-based mobile phone messages was low. The results show that the delivery of agricultural information, tailored to the different information search behaviors of farmers, is important to consider for extension programs.

Keywords: information need; information source; search behavior; agricultural extension and advisory service; willingness to pay

1 Introduction

The agriculture sector in developing countries is increasingly becoming knowledge intensive. Researchers at the global, regional, and national levels continue to generate new information. Yet as agriculture systems become more complex, farmers' access to a reliable, timely and relevant information source is critical to farmers' competitiveness. Information must be relevant and meaningful to farmers, in addition to being packaged and delivered in a way preferred by them (Diekmann et al 2009). Context-specific information could have higher impacts on the adoption of technologies and increase farm productivity for marginal and small agricultural landholders (Sammadar, 2006). However, making information context-specific is more resource intensive. It requires information at the farm-level, which could vary spatially and temporally, and with different degrees of specificity (Garforth et al. 2003). Despite the additional cost and time associated with generating localized content, its access could be more relevant and useful to meet farmers' information needs (Cecchini and Scott 2003, UNDP 2001). In addition, since developing appropriate farmer educational and marketing strategies will depend on how farmer groups differ in their information search behavior, segmentation of farmers is crucial for designing effective extension and advisory services. Thus as farmers also tend to exhibit different levels of involvement in information search an use, a better understanding of farmers' agricultural information needs and information search behaviors could help guide extension and other agricultural programs to better target specific groups of farmers. This has important implications for extension programs, where information failures in public sector extension systems has reduced extension impact (Anderson and Feder 2007; Anderson and Feder, 2004), because of limited feedback and reach to farmers reducing content relevance.

Information need assessments give program designers the ability to develop interventions that target users with specific information needs. Information needs can be classified according to the 'agricultural cycle' (Mittal et al, 2010) or the 'agricultural value chain' (de Silva and Ratnadiwakara 2008, Ali and Kumar 2011). Both approaches work through different phases of decision making a farmer needs to undergo during a cropping season – acquisition of inputs, production planning, cultivation, harvesting, packing and storing, transportation, and selling. In addition to production oriented information, off-farm income generation options and implications of changing policies are also important information needs (Van den Ban, 1998), in addition to information on sustainable natural resource management (Swanson, 2008). However, in information needs assessment a farmer may highlight an important information need based on his/her needs and interests, but 'unfelt' or unrecognized needs will not be met through this approach (Carter and Batte, 1993). Nevertheless, the value of information needs assessment, by engaging directly with users of information, should not be overlooked. A two-way process enables farmers to share lessons and best practices related to their

farm enterprise, thus incorporating their knowledge base as well (de Silva 2008). Information needs assessment should act as an initial guide to developing programs, so that contextually appropriate content is generated (Chapman and Slaymaker 2002; Roman and Colle 2003).

This paper has two tasks. First, we describe an economic approach to information search behavior among farmers. Second we present some basic evidence testing the implications of this approach by information needs of farmers and differences in needs across the farming population in two districts of Tamil Nadu, Thanjavur and Tiruvarur. It uses a farm level survey of 576 farmers using a structured questionnaire and 27 focus group discussions to examine farmers' information needs for rice cultivation and other general information. A key objective of this study is to identify farmers' information needs, the sources of their information and the preferences of their sources.

The paper is organized as follows: the next section develops a conceptual framework for assessing farmers' information needs and search behavior. Section 3 describes the study area, the methodology, and the data used in the study. Section 4 presents the results of analysis of farmer information search behavior, and how information search behavior influences farmer information needs and their preference for information sources. Section 5 discusses the policy implications. Concluding remarks form the last section.

2 Conceptual framework for assessing farmers' information needs and search behavior

In his broad review of the contributions of the economics of information Stiglitz (2000) suggests that only limited progress has been made in understanding how societies and communities such as farmer groups absorb and adapt to using new information. Also he predicted that further advances will be made on understanding how different organizational designs will influence the nature of information generation, transmission, absorption, and use (Stiglitz, 2000 p. 1471). Understanding farmers' information needs helps in designing appropriate policies, programs, and organizational innovations. At least three strands of literature that highlight the importance of information search and use are useful in the context of the economics of information in agriculture. First, studies that recognize that economic agents guide their future choices by effectively using their accumulated information and experience emphasize the role of learning equally with the search for new information (Callander, 2011). Beginning with Arrow (1962), these studies developed both theoretical and empirical evidences on how economic agents learn by experimenting with the choices of production processes. Optimal level of investments in experimentation and learning has also been explored (Aghion et al, 1991).

Since Putnam's (1993, 2000) exposition of the role of social capital in sharing and use of information by members of a community, modeling the factors that contribute to accumulation of social capital has gained importance (Glaeser et al, 2002). In the context of farmers' information search and use behavior, social capital can play a crucial role. Progressive farmers for example, could have higher propensity to invest in accumulating social capital by joining farmers' clubs and associations which may enhance their access to current information. Farmers' interaction with other farmers, private input dealers, extension works, and long-standing relationships with government officials can be captured by their level of social capital. Individual characteristics of farmers and their investments in nurturing relationships in developing relationships determine their social capital. Thus understanding the factors affecting social capital formation could be helpful in understanding farmers' information seeking behavior.

The third set of literature that connects individual characteristics to information search behavior relate to the formation of aspirations (Bernard et al, 2011). The capacity to aspire and gaps in aspiration could influence the search behavior of individuals (Ray, 2006; Appadurai, 2002). Thus, farmers' socio-economic and psychological characteristics that affect their aspirations in life could influence their search behavior.

In what follows we review selected applied studies that attempt to explain information search behavior by farmers.

Farmers are clearly not a homogenous group, and understanding the specific factors that influence their information source, access and use is a first step towards better targeting of extension programs and advisory services that facilitate information sharing. However, a majority of published literature that examine the factors that affect farmers information search behaviors, and the factors that influence farmers' use of different information sources come from studies in the developed countries.

Factors that influence use of information by farmers include their personal characteristics such as age (Carter and Batte, 1993), education (Waller et al, 1992), experience in farming (Schnitkey et al, 1992); business characteristic such as market orientation of farming (Ngathou et al, 2002), farm size (Solano et al, 2003; Alvarez and Nuthall, 2005; Llewellyn, 2007), type of farm enterprise (Carter and Batte, 1993), debt level (Tucker and Napier, 2002), ownership of farm (Ngathou et al, 2002), and geographical characteristics such as distance to market centers (Solano et al, 2003) and distance to nearest technological adopter (Llewellyn, 2007). Recent studies go beyond the factors influencing farmer information use to identify opportunities for interventions that will help increase information percolation depending on the information search behavior of the farmers. Bekele (2006) used Ethiopian farmers' subjective ranking of agricultural problems and a stated preference model to determine their preferences for development intervention. Socio-economic circumstances and ranking of agricultural problems play a major role in the type of development intervention preferred. Villamil

et al. (2008) found a high variability of preferences of information delivery among farmers, even in small geographic areas, and suggested segmenting population into target groups to increase efficiency of knowledge communication through each group's preferred information channels. Diekmann et al. (2009) describe four typologies of search behaviors based on frequency of use - low, moderate, online and high. Farmers' attitudes towards information search, farm sales, years farming, internet access, and farm type were good predictors of the information search strategies. Those farmers with more self-confidence about making decisions tended to have higher information search behavior. These studies conclude that by understanding the information needs of farmers, programs to address the needs of different groups can be better customized.

Published studies on farmer information needs and preferences are limited in developing countries. In Africa, farmer information sources and information needs have been analyzed (Aina 2006, Stefane et al. 2005, Kaniki 1991), with a number of studies that examine the factors that influence farmer search strategies (Okwu and Dauda 2011, Opara 2010, Adolwa et al 2010). In India, for example, where more than half the population is dependent on agriculture and allied activities, improved knowledge delivery to farmers is needed to support sustainable farm productivity. But the factors that influence farmers' information needs or sources are rarely explored. An analysis of the Indian NSSO 2003 survey showed that small and marginal farmers accessed less information and from fewer sources than medium and large scale farmers (Adhiguru et al. 2009). Studies like this show heterogeneity of farmer access and use of information, but greater understanding of the factors that influence information source access, use and preference is needed. Factors that influence information search strategies are not common to all regions in a country. For example, Halakatti et al. (2010) in Haveri district of Karnataka examined farmers' use of mass media, where TV was most used, followed by radio then print media. Meitei and Devi (2009) in rural Manipur found that farmers needed a variety of information related to seed varieties, pesticides, and fertilizer. The most preferred medium was radio followed by TV and newspapers. Bhagat et al (2004) interviewed 200 farmers in Jammu and Kashmir, where the most used information source was contact farmers, followed by the state department of extension staff then TV and radio. Singh (1990) surveyed 120 farmers in Meghalaya and Sikkim where information needs related mostly to cultural practices of crops, plant protection and new varieties. Singh et al. (2003) interviewed 80 farmers in Haryana and found that progressive farmers were the most frequently accessed information source. Small farmers cited market prices, weather information, information on diseases and plant protection and seed information as their top needs (Mittal et al 2010). Using the Indian NSSO 2003 survey Adhiguru et al (2009) showed that small and marginal farmers accessed less information and from fewer sources than medium and large scale farmers.

The conceptual framework presented in figure 1 is based on a combination of the literature on information needs and behavior models developed by Wilson (2006), and the economics of agricultural information framework developed by Diekmann et al (2009). Bringing these approaches together helps to show how characteristics of information search from an individual perspective translates into final welfare outcomes such as farm productivity and income through various contexts of information search, information content and its sources and how it is converted into specific action through its uses by the farmers.

Characteristics of information search depicted in figure 1 relates to a set of observable factors that could be used to explain the information search behavior of the farmers. These variables are grouped into situational factors, psychological factors, and socio-economic factors (see Diekman et al, 2009). These characteristics by themselves may not fully explain the information search behavior of the farmers. The context of information search also determines the search behavior and the information needs of the farmers (Wilson, 2006). They include the triggers during the cropping or production season such as pest incidence, shortage of rainfall, or falling prices of the community. The information search behavior of the farmers is also conditioned by the aspiration for information search and the capacity of the farmer to accumulate the social capital and the social learning skills. In addition, the contents needed and the sources of information will further refine the search behavior. The level of information search in terms of global, national, and local information sources will depend on the triggers. However, these levels could be handled depending on the sources that are accessible to farmers. For example, the local information needs could be met by a well-organized extension system that uses the traditional and modern methods of communications such as television, radio, and mobile phones. In addition farmers who have access to information technology are more likely to participate in agricultural and rural development programs and other political, social, and cultural practices (Anastasios et al, 2010). The role of NGOs and farmer based organizations are increasingly recognized as key for information sharing on specific crops and cropping systems (Swanson and Rajalahti, 2010). Finally, the private sector that develops high value agriculture chains through contract farming and input dealers who promote their agrochemicals play a critical role in filling the information gaps that may exist in rural areas (NSSO, 2005).

Finally, the conversion of the available information and its use depend on the challenges that farmer's face for which the information was needed to begin with. To access, assess and apply the content, the users must have: the economic resources, including money, skills and technology; and social resources, like motivation, trust, confidence and knowledge (Heeks 2005). Individuals must be able to not only access that content, assess its relevance and apply it to a specific decision, but ultimately to act upon the information. This requires further resources at the user level including action resources and capacity. For example, content may be available to a community, but cannot be

accessed, because of, for instance, low level of literacy; and may be accessed, but not acted upon because of poor financial capacity to buy the necessary inputs. Unless the whole information chain operates successfully at the user level, there can be no contribution of information provided by ICTs to development (Heeks 2005). As Coudel and Tonneau note 'information may seem appropriate, usable, relevant, but it can only be useful if the actors have the capacity to use it and if their environment offers them the opportunity to use it' (2010, p63). A good example of this is described in a review of different information and communication technology (ICT) initiatives in India by Sulaiman et al. (2011). This study did not find any clear correlation between the use of ICT and women empowerment. Access to information was found necessary but not sufficient, where additional complementary services and support are required. When ICT is combined as part of an integrated service, for example mobile information provided to rural women in Tamil Nadu to support goat rearing as part of a microfinance loan, the results have been more positive (Balasubramanian, et al. 2010). The nature and extension of the benefits farmers get by using information in specific operations will determine not only the productivity and welfare outcomes but also how information is sought in the next round of information search.

In order to appropriately target extension programs and advisory services it is therefore important to understand the factors that influence farmers' information search behavior and the willingness of farmers to pay for the information services, which will be explored in the following sections of this paper.

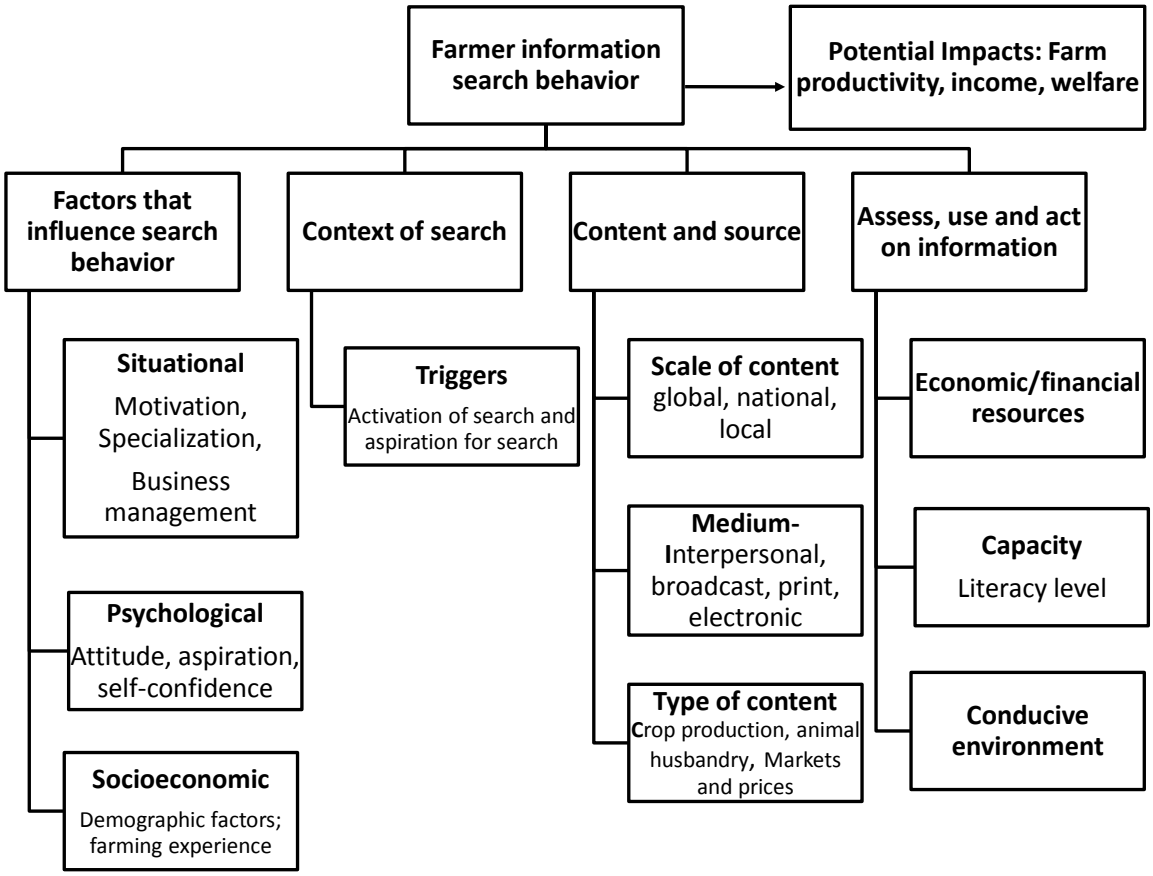
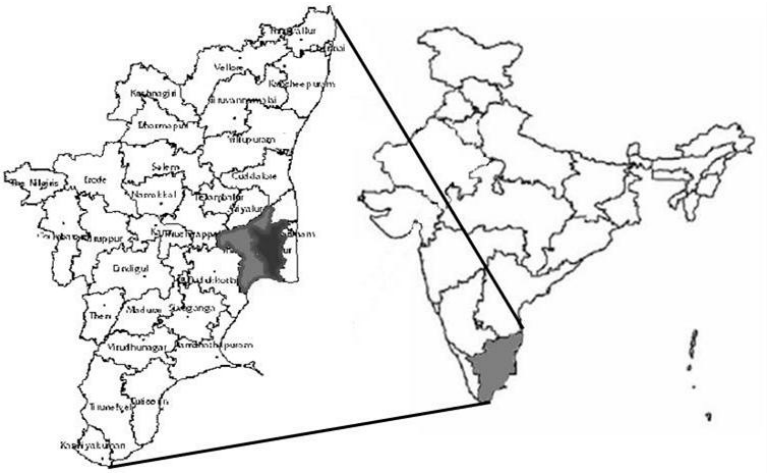


Figure 1. A Conceptual Framework of Farmers' Information Needs and Search Behavior
[Based on Diekmann et al (2009) and Wilson (2006)]

3 Study area description, data, and methodology

This study forms part of a larger effort to develop an integrated knowledge management system for the rice farmers of Tamil Nadu state in India. The focus of the knowledge management system begins with the two districts: Thanjvaur and Tiruvarur, hence the focus of these districts for this study. Thanjavur and Tiruvarur, lie on the east coast of India in the southern Indian state of Tamil Nadu (Figure 2). The region is traditionally known as the 'rice bowl of Tamil Nadu'.

Figure 2. Position of Thanjvaur (light grey) and Tiruvarur (dark grey) in Tamil Nadu state in India



Thanjavur district has a total population of about 2,216,000, of which about 66 percent live in rural areas. It receives an average 1053 mm annual rainfall with fifty-seven percent of the total area cultivated. Thanjavur district can be divided into two distinct regions based on whether agriculture has access to water from Cauvery river. The deltaic region covers the whole northern and eastern portions of the district where the Cauvery river is a major source of irrigation. The upland area or non-deltaic region is the southern and western areas of the district. Tiruvarur district receives an average 967 mm annual rainfall. This district is a deltaic plain comprising of old and new delta areas. The old delta has a network of canals and channels of the Cauvery river. The total population of Tiruvarur is 1,169,474, of which 90 percent live in rural areas. The similarities in the cropping patterns make the two districts a useful case study to examine farmer information search behaviors and information needs.

3.1 Survey data and methodology

The target population for this study was all farmers who cultivated land during 2010 in Thanjvaur and Tiruvarur districts. An initial survey instrument was pre-tested in Thanjavur district in December 2010. The survey included socio-demographic information, in addition to details on access and use of information sources. Likert scales were used to record importance of different information related to rice and other farm enterprises. A contingent valuation technique using a bidding process elicited farmers' willingness to pay for information delivered via mobile phone as a voice-based message. To complement the quantitative survey, 27 focus group discussions were conducted among various groups of farmers in eight villages. Survey data collection and focus group discussions were carried out between March and May 2011.

3.2 Survey sampling strategy

Farmers were randomly sampled (Table 1). From each district, eight blocks were randomly selected. From each of the eight blocks, four villages were randomly selected. This gave a total of 32 villages across the two districts. In each village, 18 farmers were randomly selected from the farm household list maintained by the village administrative officer (VAO), using systematic random sampling. If a randomly selected farmer had not cultivated their land in 2010, but had rented it, the farmer who rented out the land and cultivated it was instead interviewed. If the farmer was not available for interview, the next consecutive farmer on the list was identified for the interview.

Table 1. Survey random sampling strategy

District	Number of blocks	Number of villages in each block	Respondents per village	Total respondents
Thanjavur	4	4	18	288
Tiruvarur	4	4	18	288
Total	8	8	36	576

Source: authors

3.3 Focus group discussion methodology

Twenty-seven focus group discussions (FGDs) were carried out in eight randomly selected villages, from two randomly selected blocks in each district. Focus groups were formed based on landholding size and gender. In each village, three groups of male and female farmers respectively with three landholding sizes, small (less or equal to five acres), medium (five to ten acres), and large (greater than ten acres), were formed. The VAO list of landholdings was used to identify farmers. For each of the six groups, ten farmers were randomly selected to form one group. The formation of three groups of women farmers in each village was not possible. In all villages but one, only one women's group

could be formed. Group size varied, but generally contained between six to twelve farmers, depending on the situation. On average three to four FGDs were carried out in each village. The sessions were summarized, and analyzed for trends in the qualitative responses of the participants for their agricultural information needs, used information sources, preferred information medium, and bottlenecks to information searching.

3.4 Data analysis

In addition to the descriptive statistics computed from the data, cluster and factor analyses were used. Cluster analysis enabled grouping similar information search behaviors of farmers into meaningful groups. Factor analysis was applied to the different information needs related to rice, and the attitudes towards information to reduce the variables into overarching groups. These variables were then used in the models, explained below.

Information search behaviors

The high and low information search behaviors, defined using Ward's hierarchical clustering technique, were used as two separate dependent variables in two logit regression models. To determine the factors that influence high search behaviors and low search behaviors, the variables in Table 2 were used.

Table 2. Description of explanatory variables for logistic regression model and ordered probit model

Variable Name	***Description of Variable***	***Mean***	***Standard deviation***
Male head	Sex (Male=1, Female=0)	0.98	0.12
Age head	Age in years	51.80	12.07
No education	Attended school (None=1, Any=0)	0.11	0.31
Member of FBO	Member of FBO (Yes=1, No=0)	0.15	0.36
Agricultural Income	Gross income from paddy in INR	41,094.40	63,105.86
APL card	Above Poverty Line card (Yes=1, No=0)	0.65	0.48
Total Area	Total acreage cultivated for Samba	4.47	5.38
Distance	Distance to nearest market (km)	6.00	5.08
Source problem	Problem finding right source	2.84	1.07
High search attitude	Attitude for high level search	2.47	1.14
Search costly	Challenge level in information search	2.57	0.90
Ability	Ability to search	1.96	0.84
Payoff	High standards for search	2.62	0.93
Post-harvest	Post-harvest factor	2.62	1.03
Production	Crop production factor	3.60	1.06
Protection and fertilizer	Crop protection and fertilizer factor	4.72	0.53

Finance	Finance, credit, insurance factor	4.40	0.92

Source: Authors

Factor analysis on rice information needs was performed using principal component factor's method in STATA to reduce the information variables to four variables, which became 'Post-harvest', 'Production', 'Protection and Fertilizer' and 'Finance'. The same was done for the attitudinal responses to information searching, which resulted in five variables – 'Source problem', 'High search' attitude, 'Search costly', 'Ability' and 'Payoff'.

It is hypothesized that information search behaviors will be affected by the following factors. The gender and age of the individual; men may search more than women and older farmers may substitute their experience for search. It is expected that education will influence information search behaviors; with more years of schooling resulting in greater likelihood of searching more. Being a member of a farmer based organization (FBO) it is expected that search would be higher, due to interaction with farmers resulting in greater awareness of potential information sources. With higher agricultural income, information search may be higher, as the capacity to access and apply information is greater. A greater total area of cultivated land may result in higher search behavior as the results of using information may be greater. Holding an Above Poverty Level (APL) card (an indication of a higher standard of living), may increase the likelihood of high search behavior as capacity for search may be greater. Living in close proximity to a market is likely to increase high search behavior, as it may be easier and more convenient to access different information sources.

Willingness to pay for information

A contingent valuation technique was used to assess the respondents' willingness to pay (WTP) for agricultural information sent as a voice-based message service received on their mobile phone. The respondents were presented with a well-described hypothetical situation about a voice-based mobile phone messaging service. The respondents were then asked to choose whether or not they would pay for one month of mobile phone voice messages at a specified price. A structured bidding procedure was used. For example, if the respondent declined an initial high offer then the subscription price was lowered and the respondent was asked to reconsider the new offer. The offer was lowered successively until a bid was accepted or until the lowest offer was reached. An ordered probit model was estimated to determine significant variables related to respondents' willingness to pay for information through mobile technology.

The willingness to pay was estimated using a multivariate ordered probit model with eight explanatory variables (Table 2). It is hypothesized that WTP for voice message on mobile phone would be different depending on the gender and age of the individual. It is expected that education

would influence WTP; with more years of schooling resulting in more WTP, as the awareness and capacity to use mobile phones and access information from this channel may be greater. It is expected that being a member of an FBO would increase WTP, for a similar reason as explained above. If any extension service is used, WTP might be greater because of demonstrated interest in accessing many information sources. With higher agricultural income, WTP may be higher, as the capacity to pay is greater. Larger land area cultivated may increase WTP, as information needs may be greater and capacity also. Higher living standards indicated by APL card would expect to demonstrate a similar increase in WTP. Distance to market may increase WTP further from a market, as it may be more convenient to receive information directly via mobile.

4 Results

The results presented below describe the following: (1) information search and use behaviors of farmers, (2) information needs of farmers, (3) factor analysis of rice information needs, (4) attitude of farmers towards information search and factor analysis of these attitudinal variables, (5) constraint to information access, (6) information sources farmers accessed, (7) preferred information medium, (8) factors that influence information search behaviors of farmers, and (9) farmers' willingness to pay for agricultural information via mobile phone as a voice-based message.

4.1 Description of survey data

Household heads were predominantly male (98.4%), with an average age of 51.8 years (SD 12.07). Most household heads had some level of schooling, with only 7.1% of household heads who were not literate (Table 3). Membership of household heads to the Primary Agricultural Cooperative Banks (PACBs) was 67.5%, while only 15.5% were members of a farmer-based organization (FBO). Most household heads were married (96.2%). The main income source of household heads was agriculture (96.9%). District results were also similar across these variables, with no significant differences (Table 3).

Table 3. Socio-demographic variables by district of household head (percentage)

Variable	***Thanjavur***	***Tiruvarur***	***Highest education attained***	***Thanjavur***	***Tiruvarur***	***All***
Male	98.6	98.3	Not literate	8.7	5.6	7.1
Age	52.2	51.4	Literate no school	2.4	2.8	2.6
PACB member	66.8	68.3	< First Class	1.7	1.1	1.4
FBO member	14.5	16.4	Primary (1^{st}-5^{th} class)	15.2	18.5	16.8
Married	96.9	95.5	Middle (6^{th}-8^{th} class)	17.0	19.9	18.4
Main income - Agriculture	94.1	95.5	Secondary (8^{th}-12^{th})	44.3	43.2	49.7
			Tertiary	10.7	6.97	8.8

Source: Authors

The average cultivated plot size during Samba (October 2010-Febraruary 2011) crop season was 4.31 acres (SD 5.10, minimum 0.5 acres, and maximum 75 acres). There was a significant difference in the plot size (area cultivated) by district, where Tiruvarur (4.8 acres, SD 5.85) had larger average plot sizes than Thanjavur (3.78 acres, SD 4.12).

The main crop grown during Samba crop season in 2010 was rice (93%) on an average plot size of 4.4 acres (Table 4). Other crops like sugarcane and black gram were grown by a smaller number of respondents on smaller plot sizes. For example, the black gram average acreage was 2.3 acres, which is almost half that of rice (Table 4). By district, Tiruvarur cropped smaller number of crops where 98.9% was rice, while in Thanjavur only 86.8% was rice. In Thanjavur, other crops cultivated in Samba 2010 included sugar cane (5.4%), black gram (2.1%) and coconut (1.4%), and these were not cultivated in Tiruvarur.

During Samba crop season water for irrigation was mostly 'available occasionally' (46.3%) followed by 'always available' (34%). The main water source during Samba crop season was canals (63.93%) followed by tube wells/dug wells (30.92%). By district, Thanjavur had less canal irrigation than Tiruvarur (48.5% compared with 78.1%) and was supported more by groundwater sources than Tiruvarur (41.8% compared with 21.0%). There was only a very small percentage of rainfed area during the Samba crop season (0.5%).

Table 4. Main crops grown during Samba crop season in the study districts

	Respondents	***Acreage***			
Crop	**Percent**	**Mean**	**SD**	**Min**	**Max**
Rice	93.04	4.40	5.19	0.5	75
Sugarcane	2.61	3.87	5.11	1	22
Black gram	1.04	2.33	0.98	1	4
Other gram	0.87	4.80	2.17	2	7
Coconut	0.70	3.25	2.22	1	6
Groundnut	0.52	2.83	2.84	0.5	6
Other	1.22	1.57	1.97	0.5	6
Total	100	4.31	5.10	0.5	75

Source: Authors

4.2 Farmer information search behavior

Farmer information search strategies were identified using a cluster analysis based on the number of sources of information used, mean frequency of use of the information source (6=daily, 5=weekly, 4=fortnightly, 3=monthly, 2=seasonally, 1=yearly, 0=none) and the number of sources from which information was tried. Overall, the average number of information sources accessed was 3.5 (Table 5). In Thanjavur a significantly greater number of sources were accessed, and more frequently, than Tiruvarur. Among all respondents, information sources were accessed seasonally (21.4%), on a needs basis (29.6%) or daily (17.8%).

Table 5. Summary statistics for the three variables used in information search clusters

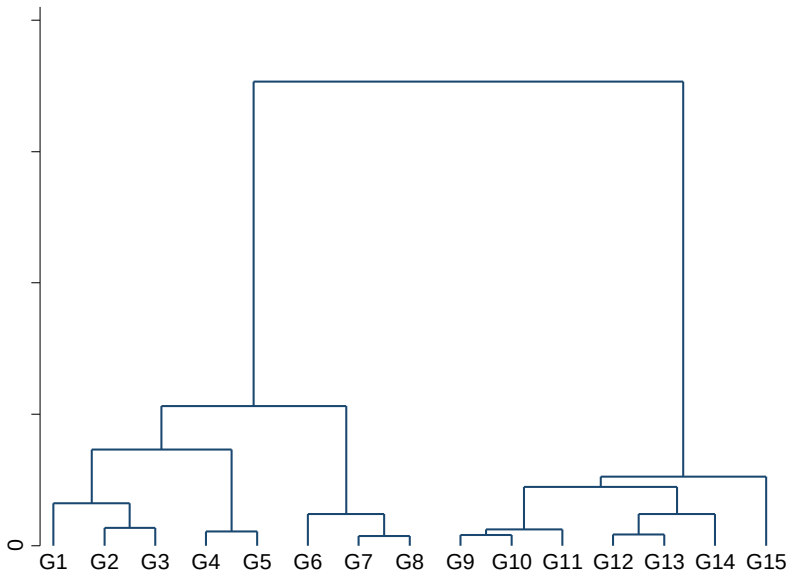
	All responders (N=576)				***Thanjavur (N=288)***		***Tiruvarur (N=288)***	
	Mean	***SD***	***Min***	***Max***	***Mean***	***SD***	***Mean***	***SD***
Number of sources accessed	3.54	1.91	0	12	3.75	2.04	3.32	1.73
Number of sources from which information tried	2.94	1.51	0	12	3.03	1.65	2.87	1.36
Mean of frequency of use (6=daily,5 =weekly, 4=fortnight, 3=monthly, 2=seasonal, 1=yearly, 0=none)	1.78	1.38	0	6	1.91	1.43	1.64	1.31

Source: Authors

Ward's hierarchical clustering was used to categorize these variables into meaningful categories. Cluster analysis organizes farmers according to the similarity or dissimilarity of the number of sources used, frequency of use, and if information was tried, placing the farmers with similar information search behaviors together as neighboring rows in the dendogram. The relationship is depicted graphically as a dendogram in which branch length is determined by the correlation between information sources used, and frequency and source from which information was tried (Figure 2). From this analysis four clusters were identified.

The four information search behaviors that emerged were high searchers, medium searchers, semi-medium searchers and low searchers (Table 6). On average, high searchers accessed 5.95 sources, on a seasonal basis and tried the information from 4.76 sources. Medium searchers, the largest group, accessed fewer sources (3.63), but with similar frequency, and tried the information from 3 sources. Semi-medium searchers were interesting, because even though they use and try fewer sources, the frequency of their use is highest amongst the information search behaviors – monthly or fortnightly. They have the smallest percentage of the total population of all the groups (8.6%). The low search group accessed the fewest sources (1.73), tried information from fewer (1.6) sources and was least frequent in accessing information sources, on average on a yearly basis (1.06).

Figure 3. Dendogram of cluster analysis for number of information sources used, frequency of information use, and number of sources from which information was tried by farmers.



Source: Authors

Table 6. Search behavior clusters identified from Ward's cluster analysis

Clusters by search behavior	***Sources accessed***		***Frequency of use***		***Information tried***	
	Mean	SD	Mean	SD	Mean	SD
High searchers Obs=148 (26.0%)	5.95	1.61	1.87	1.44	4.76	1.39
Medium searchers Obs = 213 (37.4%)	3.63	0.69	1.70	0.99	3.00	0.63
Semi-medium searchers Obs=49 (8.6%)	2.24	0.72	4.17	1.16	1.92	0.73
Low searchers Obs=160 (28.1%)	1.73	0.50	1.06	0.93	1.60	0.54
	F=504.98 Prob>F=0.0000		F=358.65 Prob>F=0.0000		F=358.65 Prob>F=0.0000	

Source: Authors

The four farmer information search behaviors differ significantly by the variables post-high school studies, ration card type indicating poverty status, land area cultivated, agricultural income and membership to a PACB, and membership to a farmer-based organization (FBO) (Table 7). Low searchers have the lowest average of the groups of those who have studied beyond high school, whereas high searchers had the largest. Holding a post-high school diploma or degree may increase awareness and capacity of farmers to use and try more information sources. High searchers have

higher average cultivated land area, agricultural income and Above Poverty Level (APL) status than the other search clusters, with the low searchers having the lowest average cultivated land area, agricultural income and holders of APL card holders. These variables reflect capacity to access information and apply the information, as risk-taking capacity is higher than a low searcher. Larger land area and income may also influence motivation to search for information as interest in agriculture may be greater. This was also suggested during the farmer group discussions (FGD), where lack of interest in agriculture was most noticeable in small landholders. Membership to FBO is greatest for high and medium searchers, and lowest for the semi-medium searchers. Membership to FBOs may increase awareness of information sources and availability. For agricultural income and membership to FBOs, the semi-medium search category has an average income greater than the medium group, and the lowest average membership to FBOs, lower than that of the low search group**.** Membership to PACB was greatest for the high search group, and lowest for the semi-medium group. Membership to a PACB gives better access to credit and inputs, which might also influence access to agricultural information as well.

This section has categorized farmers by their information search strategies by the number of sources accessed, frequency of use and number of sources from which the information is tried. The resulting categories are high searchers, medium searchers, semi-medium searchers and low searchers. These categories are different by many variables including their level of education, land holding size, and income. These information search behavior groups are used to further explore differences in information needs, attitude towards information searching, and preferred information sources in the following sections.

Table 7. Search behaviors by socio-demographic characteristics.

Variable	***HIGH***		***MEDIUM***		***SEMI-MEDIUM***		***LOW***		***ANOVA***
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	
Age	51.08	12.42	52.44	11.85	53.53	13.31	51.05	11.46	n.s
Male head	0.98	0.14	0.98	0.14	0.98	0.14	0.99	0.08	n.s
No Schooling	0.09	0.28	0.10	0.30	0.18	0.39	0.13	0.33	n.s
Graduation (post-12 class)	0.16	0.36	0.07	0.25	0.06	0.24	0.04	0.19	F=5.47, Prob>f=0.001
SC/ST	0.18	0.38	0.22	0.42	0.16	0.37	0.22	0.41	n.s
APL	0.82	0.38	0.61	0.49	0.61	0.49	0.58	0.50	F=8.88, Prob>f=0.0000
Cultivated area Samba (acres)	5.72	6.50	4.84	6.21	3.75	3.32	3.17	2.65	F=6.10, Prob>f=0.0004

Distance to market (km)	5.49	4.68	6.22	5.38	5.33	4.17	6.27	5.31	n.s
Ag income (INR)	55 415	79 450	39 065	68 246	44 963	50 782	30 306	34 049	F=4.18, Prob>f=0.0061
Member of PACB	0.78	0.41	0.68	0.47	0.59	0.50	0.61	0.49	F=4.2, Prob>f=0.0059
Member of FBO	0.30	0.46	0.11	0.32	0.08	0.28	0.11	0.31	F=10.67 Prob>f=0.0000

Source: Authors

The four search behaviors also differ significantly by district, where Thanjavur has the greater number of higher searchers, while Tiruvarur has greater numbers of low searchers (Table 8).

Table 8. Search behaviors by district

	Thanjavur	***Tiruvarur***
Search behaviors	**Percent**	**Percent**
High	30.88	21.05
Medium	32.98	41.75
Semi-medium	10.88	6.32
Low	25.26	30.88
	F=4.66, Prob>F=0.0032	

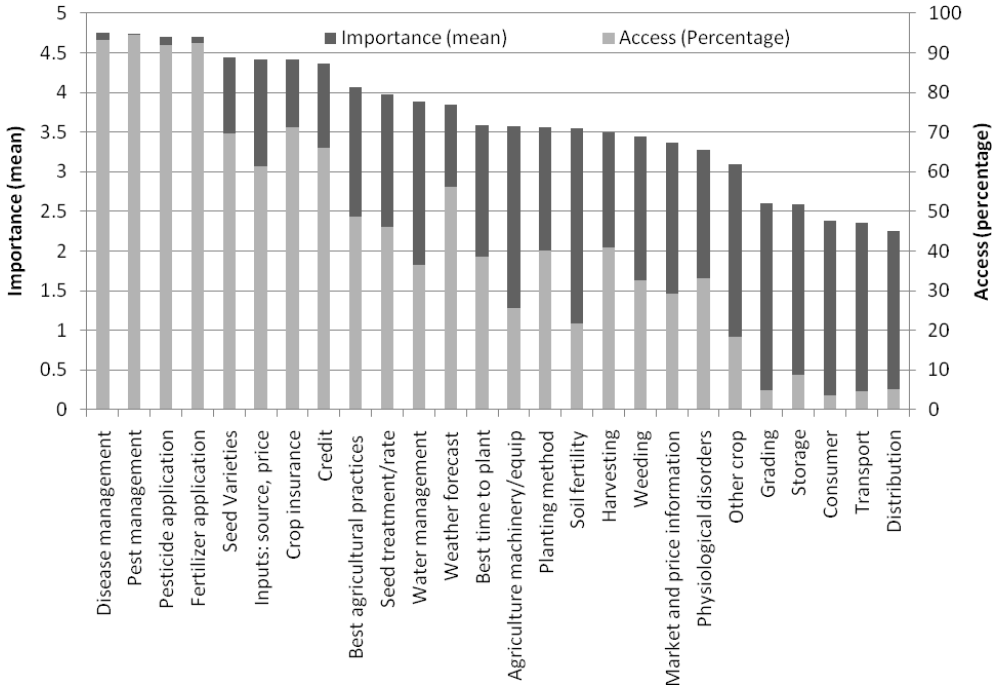
Source: Authors

4.3 Farmer information needs

Information needs related to rice cultivation

Farmers' importance of information needs related to rice was gauged using a five point Likert scale. The most important information needs for rice are: disease and pest management followed by pesticide and fertilizer application. Seed varieties and inputs were also considered important, but were not accessed as much considering the importance given to this need (Figure 4). The information given the lowest importance was related to post-harvest aspects – grading, storage, consumer behavior, transport and distribution (Figure 3). Similar pattern of importance of information needs for rice also emerged from the qualitative analysis of the farmers group discussions.

Figure 4. Rice information needs by importance* and percentage who had accessed that information



*on a 5-point Likert scale (1= not important, 2= less important, 3= neutral, 4= somewhat important, 5= very important). Source: Authors' calculation

The four most important information needs (disease and pest management, pesticide and fertilizer application) were accessed mainly from input dealers, while seed variety information was obtained primarily from the extension staff of the state department. Crop insurance and credit information was obtained primarily from PACBs (Primary Agricultural Cooperative Banks). Best practices information was obtained primarily from public extension staff as well.

Table 9. Importance of rice information needs by search behavior clusters (1= not important, 2= less important, 3= neutral, 4= more important, 5= very important)

			Search Behavior Clusters							
			Low		**Semi-medium**		**Medium**		**High**	
Information	**F**	**Prob>F**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
pest management	0.42	0.7404	4.72	0.53	4.83	0.38	4.73	0.59	4.76	0.55
disease management	0.29	0.5320	4.74	0.54	4.83	0.38	4.73	0.62	4.76	0.55
pesticide	2.45	0.0624*	4.78	0.48	4.46	1.09	4.66	0.69	4.70	0.66
fertilizer	1.22	0.3032	4.79	0.46	4.66	0.64	4.66	0.69	4.70	0.73
inputs	0.74	0.5314	4.51	0.76	4.31	0.76	4.41	0.90	4.39	0.92
crop insurance	2.15	0.0926*	4.57	0.86	4.60	0.91	4.33	1.07	4.36	0.95
credit and loans	0.79	0.4987	4.39	1.04	4.60	0.81	4.33	1.06	4.33	0.92
seed varieties	2.14	0.0940*	4.49	0.87	4.71	0.67	4.43	0.87	4.32	0.93
seed treatment	4.56	0.0036**	3.67	1.43	4.00	1.37	4.02	1.20	4.21	0.99

best ag practices	5.11	0.0017**	4.28	1.02	4.37	0.81	4.03	1.14	3.82	1.08
weather	1.83	0.1402	3.72	1.30	4.14	1.12	3.96	1.30	3.74	1.41
water management	5.19	0.0015**	4.19	1.20	4.17	1.25	3.81	1.34	3.62	1.33
soil fertility	0.81	0.4899	3.55	1.51	3.20	1.55	3.56	1.40	3.61	1.31
ag machinery	2.64	0.0491**	3.72	1.26	4.00	1.08	3.44	1.40	3.50	1.33
physiological	1.01	0.3877	3.12	1.35	3.43	1.31	3.34	1.34	3.33	1.20
planting method	12.59	0.000***	4.03	1.19	3.74	1.22	3.47	1.24	3.18	1.07
best time to plant	12.04	0.000***	3.96	1.22	4.00	1.14	3.53	1.23	3.17	1.04
market and price	3.28	0.0209**	3.64	1.45	3.60	1.35	3.22	1.58	3.14	1.60
other crops to plant	0.27	0.8457	3.11	1.41	2.91	1.36	3.12	1.33	3.13	1.08
weeding	16.91	0.000***	4.06	1.24	3.80	1.28	3.24	1.39	3.03	1.28
harvesting	16.86	0.000***	4.03	1.29	3.94	1.30	3.39	1.49	3.00	1.40
grading	0.78	0.503	2.54	1.43	2.91	1.58	2.63	1.34	2.54	1.36
storage	0.58	0.6276	2.67	1.41	2.69	1.30	2.57	1.27	2.48	1.20
transport	0.71	0.5434	2.41	1.35	2.34	1.37	2.38	1.20	2.21	1.16
distribution	0.68	0.5675	2.37	1.38	2.31	1.39	2.19	1.29	2.18	1.29
consumer	7.66	0.0001***	2.67	1.26	2.71	1.43	2.34	1.31	1.96	1.32

*, **, *** - means significant at 0.10, 0.05 and 0.01 respectively

Source: Authors

Significant differences emerge between importance given to certain information by the four clusters of information search behaviors (Table 9). For low searchers more importance is given to pesticide application information, which is given lower importance for high, medium and semi-medium searchers. This is also similar for water management, planting method, market and price, weeding and harvesting information. Low searchers have smaller land area, lower income, and access less information sources. They give more importance to rice cultivation information than the other search groups, probably because they are currently not able to easily access this information or do not know which sources are available to access this information. Again a similar pattern emerges for seed varieties information, crop insurance, best agricultural practices, agricultural machinery and best time to plant information, except that semi-medium searchers give greater importance than the low searchers. Seed treatment has high importance for high searchers compared with other groups.

Pest and diseases in rice

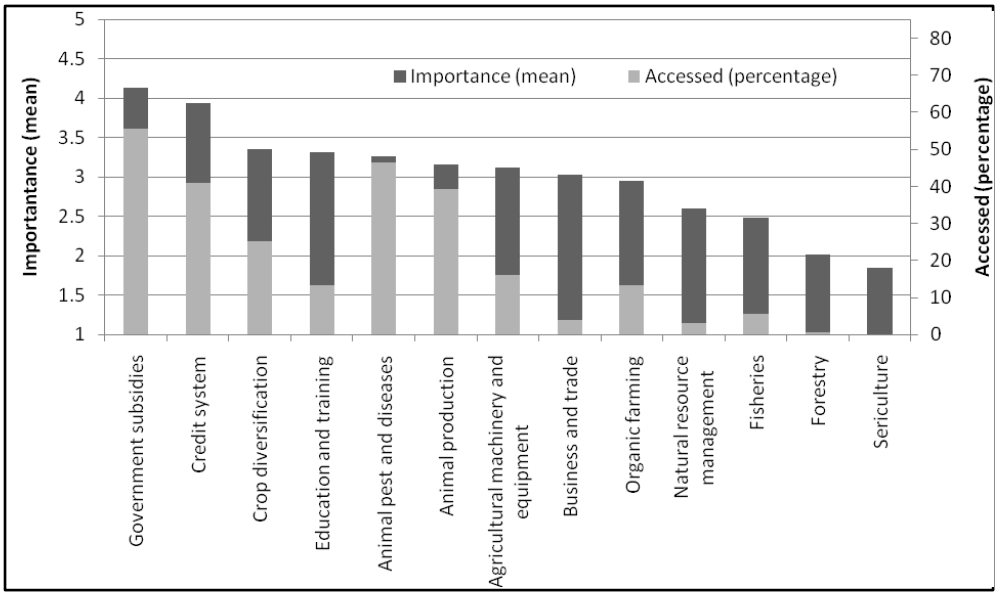
Farmers needed information on a number of rice pests and diseases, which were similar across the districts. These included: stem borer (41.6%), BPH (brown plant hoppers) (24.6%), leaf folder pest (14.2%) and ear head bug (13.6%). There was no significant difference with pest information needed

by search groups. The main diseases for which information was needed included: sheath blight (35%), blast (18.7%), false smut (13%), rot (10%), helminthsporium leaf spot (7.8%), yellow disease (7.4%) and rice tungro virus (7.2%). These were significantly different by information search groups, where high and medium searchers preferred information on blast and sheath blight, while the semi-medium and low search groups also would like more information on helminthsporium and false smut.

Non-crop information needs

Farmers require other information beyond rice crop specific information. A five point Likert scale was used to determine the importance of other non-crop information farmers require. High importance was given to government subsidies and credit information, which are both sourced mainly from the PACB (Figure 5). This was again supported by the qualitative information exchange during farmer's group discussions (FGDs), where many of the groups highlighted the need for more information on government subsidies, particularly related to seed and machinery.

Figure 5. Non-crop information needs (1=not important, 2=less important, 3=neutral, 4=somewhat important, 5=very important)



Source: Authors

Significant differences emerge by information search behaviors for credit system information, education and training information, organic farming, and forestry information (Table 10). Importance increases from low to high searchers for education and training, organic farming and forestry. This information may have more relevance for high and medium searchers who have larger land area and income, and more schooling, and therefore able to expand their farm enterprise beyond rice cultivation and consider organic farming and forestry for example. In comparison, credit system

information is more important for semi-medium and low searchers than high and medium searchers. Credit for low and semi-medium searchers would be more important because they may not have easy access to financial services.

Table 10. Other information needs by search behaviors

Other information			High		Medium		Semi-medium		Low	
	F	Prob>F	Mean	SD	Mean	SD	Mean	SD	Mean	SD
govt policies	0.11	0.9571	4.14	1.20	4.15	1.14	4.18	1.03	4.09	1.25
credit system	7.47	0.0001***	3.57	1.37	3.95	1.25	4.22	1.03	4.20	1.16
education and training	2.95	0.032**	3.56	1.40	3.32	1.36	3.18	1.27	3.11	1.35
animal production	0.98	0.4008	3.25	1.38	3.25	1.38	3.12	1.39	3.03	1.48
animal pest and disease	0.44	0.7233	3.23	1.41	3.33	1.47	3.31	1.46	3.16	1.56
organic farming	4.17	0.0062**	3.17	1.41	3.05	1.53	2.80	1.47	2.61	1.57
crop diversification	1.82	0.1429	3.14	1.50	3.41	1.49	3.65	1.48	3.41	1.52
business and trade	0.93	0.4243	3.14	1.34	2.93	1.28	3.16	1.21	3.04	1.28
ag machinery	2.06	0.1048	3.08	1.45	3.26	1.46	3.22	1.49	2.89	1.55
natural resource management	1.93	0.1233	2.70	1.27	2.66	1.32	2.59	1.31	2.38	1.33
fisheries	0.61	0.611	2.55	1.47	2.54	1.50	2.29	1.51	2.42	1.44
forestry	2.72	0.0438**	2.18	1.12	2.08	1.13	1.84	1.03	1.87	1.03
sericulture	1.01	0.3894	1.93	1.01	1.91	1.06	1.76	0.99	1.77	0.97

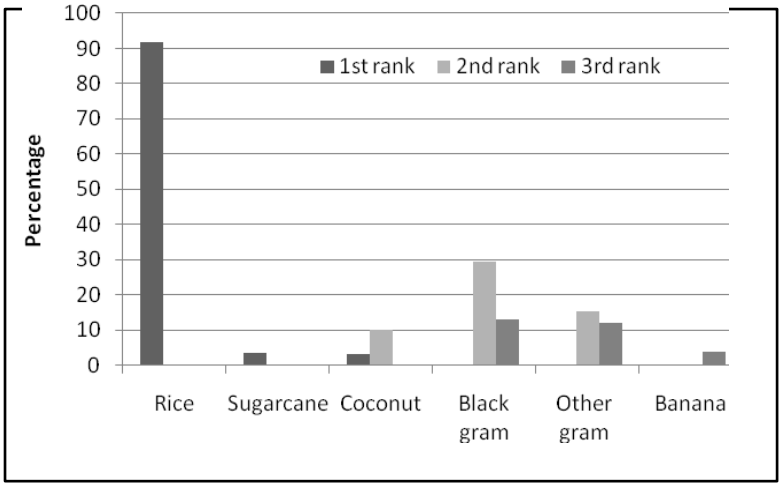
*, **, *** - means significant at 0.10, 0.05 and 0.01 respectively

Source: Authors

Crops for which information needed

The main crop for which information is required is rice (Figure 6). Coconut, sugarcane, black gram and other gram and to a small extent banana were also identified. The FGDs highlighted these crops, which differed within each of the eight group discussion villages, where, for example, one village in Tiruvarur had only one crop season of rice, while another in Thanjavur cultivated rice, black gram and groundnut. In another the village cultivated rice for consumption, while coconut was cultivated for sale.

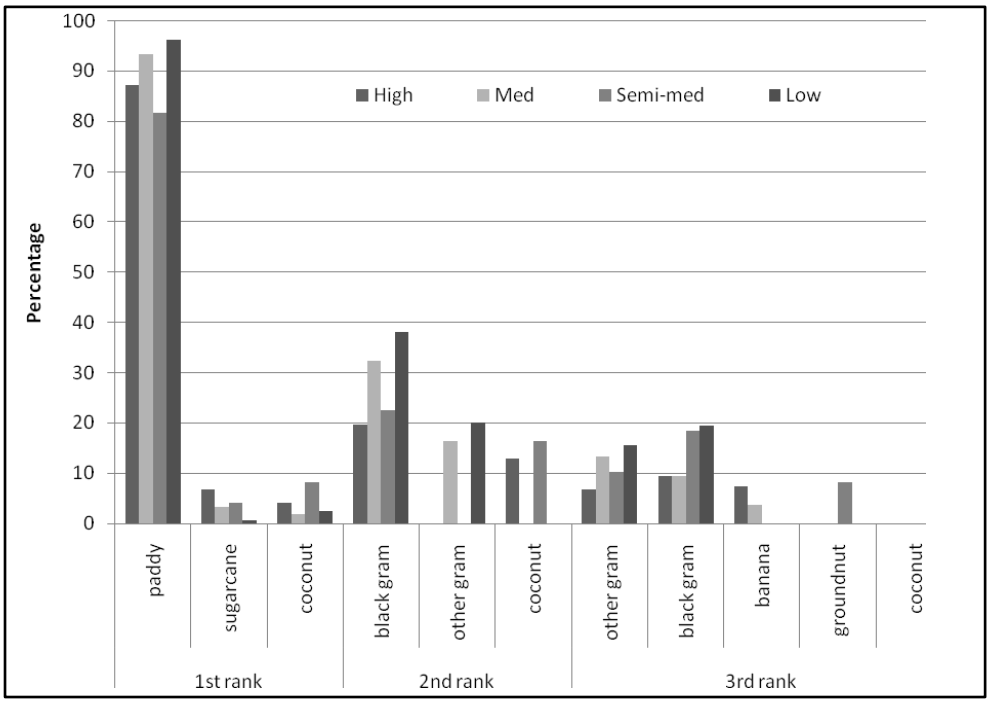
Figure 6. Crops 1st, 2nd 3rd rank for which information most required



Source: Authors' calculation

There is a significant difference between information search behaviors and crops when ranked, where high searchers gave more importance to coconut and sugarcane (Figure 7). Low searchers gave higher preferences to black gram and other gram after rice.

Figure 7. Top three crop ranks for which information needed by farmer information search behavior



Source: Authors' calculation

In summary, for all farmers, the most important information needs for rice are disease and pest management, and pesticide and fertilizer application. By farmer information search behavior these differed significantly for pesticide application, which was more important for low searchers. Credit was also more important for semi-medium and low searchers. These results show that, while there are

some similarities between information needs of farmers their importance differs between information search behavior clusters.

4.4 Rice information needs factor analysis

Principal components analysis was used to reduce the 26 rice information needs to four overarching groups. Each group becomes a composite variable for use as an independent variable in the regression models (Table 2).

Factor analysis, using principal components methods and Varimax rotation, reduced the information topics into six factors. Eigen values for each factor was greater than one. Variables with a minimum loading of 0.5 were selected for inclusion in defined components similar to Tucker and Napier (2002). Reliability analysis using Cronbach's alpha was carried out on the composite variables. Factors that produced a minimum coefficient α of 0.7 were considered appropriate for further analysis similar to Villamil et al. (2007). Four factors emerged from the analysis and were named 'Post-harvest', 'Crop production practices', 'Plant protection and fertilizer' and 'Finances' (Table 11). The four factor variables were calculated using an average summated score, e.g for 'Finances' variable = ((credit + insurance)/2).

Table 11. Factors derived from principal components analysis with corresponding Cronbach's alpha, variables and loading for each variable

Post-harvest (α=0.87)
Machinery (0.55), Storage (0.84), Grading (0.81), Transport(0.86), Distribution (0.74)
Crop production practices (α=0.86)
Time to plant (0.79), Planting method (0.81), Weeding (0.77), Water (0.67), Harvesting (0.80)
Protection and fertilizer (α=0.89)
Pest (0.87), Disease (0.87), Pesticide (0.84), Fertilizer (0.85)
Finances (α=0.86)
Credit (0.90), Insurance (0.89)
Seed (α=0.60)
Seed variety (0.71), Seed treatment (0.66)

Source: Authors' calculations

The four information search behaviors only significantly varied for the 'Finances' information variable. Semi-medium and low searchers gave greater importance to this factor than high and medium search groups (Table 12). This was already seen from the importance given by them to non-crop information (Table 10).

Table 12. Four factors of rice information needs by search group

			High		*Medium*		*Semi-med*		*Low*	
Variable	**F**	**Prob>F**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Plant protection and fertilizer	1.93	0.1239	4.73	0.56	4.70	0.58	4.69	0.51	4.76	0.43
Finances	18.4	0.000***	4.34	0.89	4.33	0.99	4.60	0.75	4.48	0.89
Crop production practices	0.39	0.7582	3.20	0.92	3.49	1.05	3.93	0.98	4.05	1.03
Post harvest	1.39	0.2453	2.48	0.97	2.59	1.02	2.83	0.97	2.73	1.11

*, **, *** - means significant at 0.10, 0.05 and 0.01 respectively

Source: Authors' calculations

4.5 Farmer attitude towards information

Farmers' attitude towards searching for information was explored using statements developed by Diekmann et al. (2009). These statements were developed from marketing literature. The results are displayed in Table 13.

Table 13. Attitude toward information

Attitude towards information	***Mean*** *(1=strongly agree, 2=somewhat agree, 3=neutral, 4=somewhat disagree5=strongly disagree)*	***SD***
search a lot for information	2.33	1.48
compare information from different sources	2.73	1.31
selecting source is important	2.34	1.22
need assistance from intermediary	1.89	1.14
don't know information needed	3.02	1.36
little access to information	2.56	1.23
difficult to find right information	2.52	1.30
takes lot effort to search information	2.48	1.33
hard to decide where to look	2.42	1.34
hard to decide which information to trust	2.81	1.40
feel confused by information available	3.13	1.40
should spend more time searching	2.88	1.37
not lucky funding useful information	2.90	1.30
feel takes time to search for information	2.56	1.34
much to lose when using wrong information	2.10	1.33

beneficial to search for information	1.96	1.06
more self-confident than others	2.00	1.12
like to be considered a leader in farming	2.23	1.23
helpful to friends who have difficulty finding the right information	1.65	0.92
quite knowledgeable about farming	2.57	1.24
pays to select the best source	2.47	1.17
high standards for information used	2.62	1.27
get as much information as possible before making decision	1.91	1.04
unbiased information important	1.70	0.85
use many information sources	2.81	1.33
pressure to find information need quickly	2.22	1.20
use same source as in past	2.18	1.22
economic consequence of poor choice concern in seeking information	2.51	1.40
rely on traditional knowledge	1.99	1.14
rely on own experience	1.71	1.00
reply on information sourced	2.33	1.27

Strong agreement were for statements including: needing help with an intermediary, seeing benefit in searching for information, being helpful to friends, and relying on own experience. But for most of the statements agreement was close to neutral. In the FGDs, farmers said that their interest in farming was low, because it was not profitable. This was particularly true for the small landholders. Also farmers said in the FGDs they did not know what information they needed. This statement received a neutral response in the survey however (Table 13).

The statements were grouped using factor analysis using the same methodology as the factor analysis for rice information needs. Five factors emerged from the analysis and were named 'Source problem', 'high search attitude', 'Search costly', 'Ability', and 'Payoff' (Table 14). Of the four attitudinal variables, 'Payoff', 'Search costly', and 'Source problem' were significantly different between farmers information search groups (Table 15). The high search group somewhat agreed with payoff from information search, while the other search groups were neutral. The attitude of a high searcher will be to use many sources, have high standards for the information used, try to select the best source and feel quite knowledgeable. The high search group did not find search as costly as the other search groups, with a close to a neutral average agreement to 'Search costly'. The low search group found searching for information the most costly. The low search group also somewhat agreed with having a problem sourcing information, whereas the other groups were neutral about this factor (Table 15).

Table 14. Factors for attitude toward information using principal components with Cronbach's alpha's and loadings

Source problem (α=0.79)
don't know information needed (0.66), hard to decide where to look (0.51), hard to decide which info to trust (0.77), feel confused by info available (0.78)
High search attitude (α=0.81)
search lot (0.73), compare information (0.79), selecting source important (0.72)
Search costly (α=0.78)
little access to information (0.69), difficult to find right information (0.53), takes lot effort to search information (0.58), not lucky finding useful information (0.58), feel takes time to search (0.63)
Ability (α=0.77)
beneficial to search for information (0.55), more self-confident than others (0.73), like to be considered leader (0.70), helpful to friends (0.78)
Payoff (α=0.73)
quite knowledgeable (0.60), pays to select best source (0.63), high standards for info used (0.65), use many info sources (0.54)
Time and money cost (α=0.59)
much to lose from using the wrong information (0.76), use same source as in past (0.61), economic consequence concern (0.71)

Source: Authors' calculation

Table 15. Four factors (1=strongly agree, 2=somewhat agree, 3=neutral, 4=somewhat agree, 5=strongly disagree)

			High		***Medium***		***Semi medium***		***Low***	
Variable	**F**	**Prob>F**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Ability	1.45	0.228	1.85	0.81	2.01	0.90	1.87	0.78	2.00	0.77
High search	1.32	0.2681	2.30	0.99	2.47	1.10	2.54	1.09	2.54	1.27
Payoff	2.54	0.0557*	2.45	0.87	2.60	0.93	2.68	0.97	2.73	0.92
Search costly	4.63	0.0033**	2.76	0.92	2.58	0.92	2.59	0.88	2.38	0.83

Source problem	8.08	0.000***	3.06	1.08	2.91	1.05	2.92	0.89	2.50	1.07

*, **, *** - means significant at 0.10, 0.05 and 0.01 respectively

Source: Authors' calculation

4.6 Farmer information sources

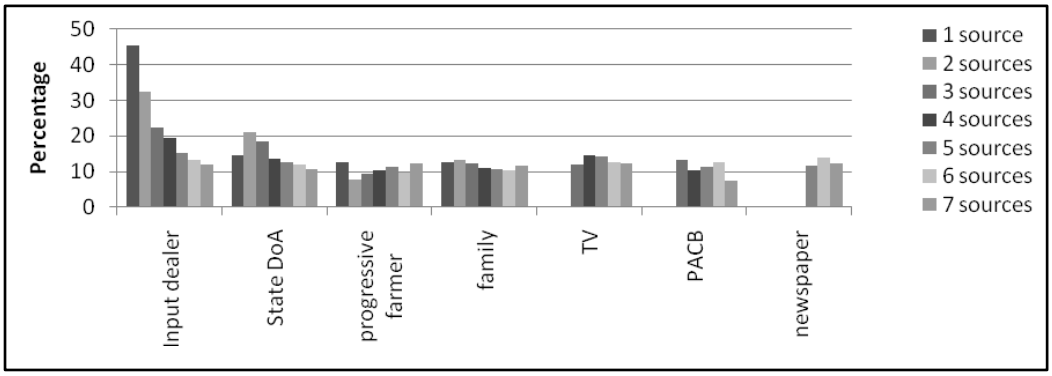
Main information sources

The main sources farmers relied on for agricultural information in 2010 was the private input dealer (68.6%), followed by the state government department of agriculture extension staff (51.2%), then television (43.6%), family members or relatives (39.9%), progressive farmers (36.2%), PACBs (35.7%) and newspapers (30.6%). Farm magazines were accessed by 9.2%. Only a small percentage used radio (5.4%) and farmer group associations (4.7%) for information. The sugar factory was a source for 2.8% of respondents. The public sector research stations and Krishi Vigyan Kendras (Farm Science Centers) were accessed by even fewer respondents - 1.7% and 1.6% respectively. While the use of the input dealer for information in India is well acknowledged (the NSSO 2003 survey found that it was the second major source of information used (NSSO, 2005)), it is interesting to note the high use of the state government department of agriculture extension staff (AO – agricultural officer and AAO – assistant agricultural officer) and TV for information.

These results were further supported by the results of the FGDs. Aside from relying on their own experience, the main sources for agricultural information highlighted in the farmer group discussions were the input dealer, neighbors and relatives, and the AO or AAO. There were a number of bottlenecks to using these sources however. While providing inputs on credit, the input dealer was criticized for exploiting farmers' time pressure to purchase inputs by pushing certain products. In one village farmers said that each of the input dealers sold products from only one company so it was difficult for farmers to compare product prices. One farmer said that farmers tend to follow the input application and use patterns of their neighbors, so information is integrated between different sources to apply inputs. Despite the use of the state department of agriculture staff, there were many complaints about the service provided by the staff. In some villages the AO did not visit frequently or was not interested to talk with farmers, while in another the extension staff dealt with only certain farmers, namely progressive farmers. In one village the women's group identified that the AAO for their village was female, and she interacted with them. This compares with another village, where the women's group said that the male AO did not interact with them. The women in this group had participated in the TANWA program (Tamil Nadu Women in Agriculture Program), which ran from 1998-2004. They said during that time the AO worked closely with them, and today the benefits of the training they received were still being felt, for example one woman said she could successfully

identify pests and diseases in their crops. Some considered the information from the extension staff not trustworthy, and inconsistent with other information sourced. Despite the problems identified in the FGD, the AAO was suggested as a preferred source of information. The women groups often cited their husbands as information sources as well. Farmers watched their neighbors' fields, met with other farmers in tea shops, and spoke with progressive farmers.

Figure 8. Type of sources accessed by number of sources accessed (from 1 to 7)



Source: Authors' calculation

It is interesting to note that the reliance of the input dealer decreases as the number of information sources increases (Figure 8). As more sources are used, the use of each source becomes almost even. For certain sources though there is a similar percentage of use regardless of the number of sources accessed – that is family/relatives and progressive farmers. Television, the PACB and newspaper become important sources of information as more sources are accessed.

The main reason for choice of source was proximity (33.7%), assured quality (21.1%), only available option (20.6%), and timely availability (13.7%). The main crop for which information was obtained was rice (72.8%), sugarcane (5.8%), coconut (5.1%), and black gram (3.1%). The average distance to the information source was 5.3km (SD 22.46). The main reason for not using other sources listed included: not available (68.4%), do not know about the source (16.2%), poor service (9.2%), and low relevance (3.0%). The main type of information received was on plant protection (28.2%), overall crop information (22.0%), cultivation practices (14.2%), government subsidies (8.9%), general information (5.5%), and credit (6.0%). This reflects the important information needs.

The different information sources accessed were combined into four overarching groups based on type of medium including print, broadcast, electronic, and interpersonal. These four media groups were then used to analyze access by information search behaviors. Low searchers relied on interpersonal sources, like the input dealer, state department of agriculture extension workers, family and relatives, progressive farmers and PACB (Figure 9). Semi-medium searchers accessed all media, with the most use of electronic sources (Table 16). High and medium searchers also accessed print and broadcast media (Table 16).

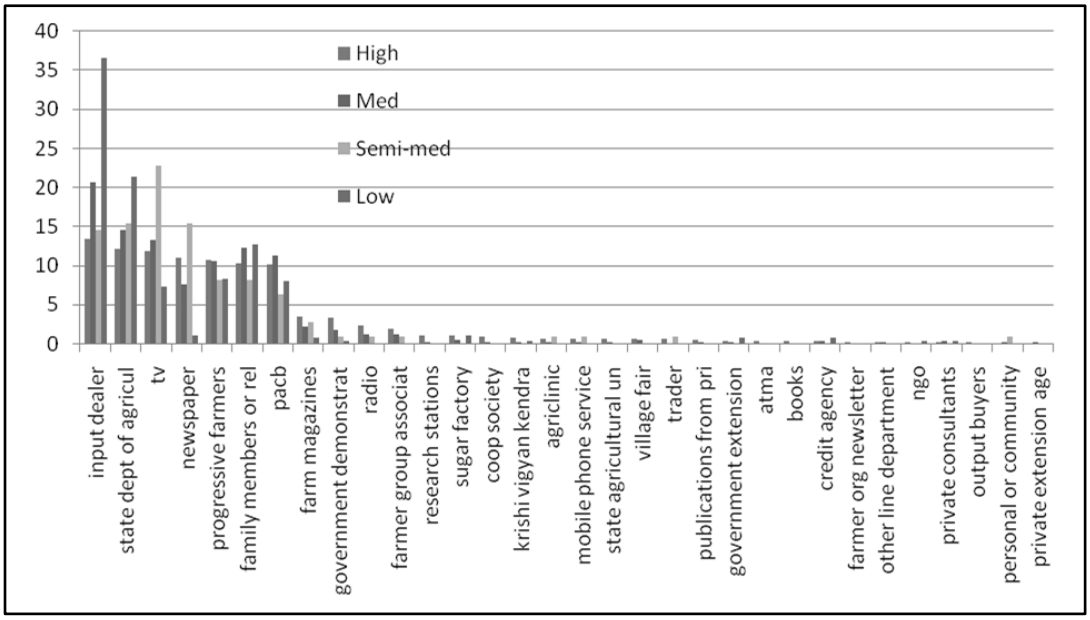
Table 16. Fraction of medium used by each search behavior

			High		Medium		Semi-medium		Low	
Fraction of each medium accessed	**F**	**Prob>F**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Broadcast fraction	61.96	0.0000***	0.42	0.29	0.26	0.27	0.27	0.25	0.06	0.17
Interpersonal fraction	53.3	0.0000***	0.19	0.06	0.12	0.03	0.06	0.03	0.08	0.05
Print media fraction	2.72	0.0437**	0.16	0.15	0.06	0.09	0.07	0.08	0.01	0.03
Electronic fraction	195.35	0.0000***	0.02	0.10	0.00	0.05	0.02	0.14	0.00	0.00

*, **, *** - means significant at 0.10, 0.05 and 0.01 respectively

Authors' calculation

Figure 9. Sources accessed by each search behavior



Source: Authors' calculation

Aside from other farmers, the majority of farmers, particularly the low searchers, rely on the input dealer for information, though the government extension staff also is a large source of agricultural information. By information search behavior, there are significant differences in the medium used. Low searchers do not use electronic sources and very little print media sources. They rely on broadcast and interpersonal sources. This can have important outcome for targeting users for information. Low searchers, who have smallest land area, and lowest income are better reached through interpersonal sources and broadcast media, like TV or radio.

Constraints to information access

The major constraints to information access were poor availability and reliability of information. Respondents also cited lack of awareness of information sources available and that the information available was not timely. The first major information constraint ranked by each cluster shows some differences between the groups, though using ANOVA, these differences are not significant.

The focus group discussions provided more insights into the bottlenecks of accessing information. Lack of credit meant that for many applying new information may be costly as capacity for risk taking was low. There was also some frustration in application of the information, with one instance where the information failed, and another where there was no change in yield. One example given was for the SRI technology (system for rice intensification), where farmers had access to incomplete information. One woman said "we need information that does not increase our cost of cultivation, but keeps the costs the same or reduce them". Information from the public sector extension system (university, research stations, and AOs/AAOs) was described as being "locked" and difficult to access. Follow-up and field visits were lacking. Lack of interest in agriculture, due to poor profits, and lack of credit, reduced the incentive to search for information, with many saying they did not know what information was needed.

While access to reliable and timely information is important to farmers, the main major bottlenecks farmers cited to improving their farm income were related to the physical resources and natural situation, including climate variability, flood conditions and inadequate irrigation, in addition to poor access to markets. High costs of inputs, labor availability and access to markets were also ranked as major bottlenecks to improving their farm income. From the FGD, particularly in Tiruvarur district, a number of water management issues were mentioned, including flooding problems that affected cultivation. Poor road access affected one village, where transport costs were high. These are contextual issues within each village and important to understand in order to address their specific information needs which are influenced by these issues.

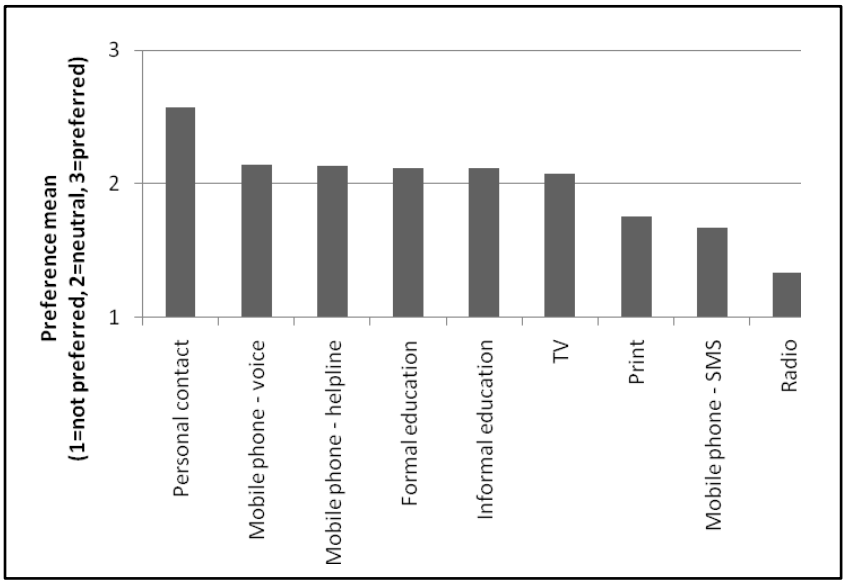
Despite the constraints, respondents considered the information received from the sources they used as very relevant (59.2%) or somewhat relevant (27.5%). About 83.2% of the information received was tried. The main reason for not trying information was because of poor relevance and usefulness (40.5%) and lack of technical advice for follow-up (28.4%) or poor format (18.1%). Suggestions for improvements included better quality and reliability (23.4%), better timeliness (15.8%), increasing frequency of meetings or demonstrations (10.8%), improvement in professional competence (9.4%) and taking greater consideration of farmers' needs and interests (8.3%).

4.7 Preferred information medium

The most preferred medium was personal contact followed by mobile phone voice messages and a mobile phone helpline (Figure 10). The preferred language was Tamil (99.0%). The FGDs provided

some more insights into the preferred information by medium. Direct contact was almost always the preferred medium in all the FGDs, particularly the women's groups, with the AAO often suggested as the preferred contact. Training and demonstration programs were also preferred. The mobile phone helpline was also suggested as a useful practice. In fact, a number of farmers had tried to access to national toll free phone number for farmers, the Kisan Call Center, but always there were problems in receiving a response. Another interesting suggestion was the use of a public notice board to display information. The village tea shop was often cited as a place where information was shared among the male farmers – "if four farmers gather in a place for four minutes, the word coconut would be spoken at least four times". When asked about which ICT media was most preferred, TV arose often, though better timings (mainly from the women's groups) and more local contextualization was suggested. Voice message via mobile phone was preferred over SMS messages due to literacy limitations.

Figure 10. Preferred information medium



Source: Authors' calculation

The preferred medium significantly differed by search behavior for the mobile phone helpline, print media, and TV (Table 17). The mobile phone helpline was preferred by the high search group and preference declines for the semi-medium and low groups. Print media was least preferred by low search groups and medium search groups. High and semi-medium search groups were neutral for print media. TV was more preferred by semi-medium search groups.

Use of different media to access information has already been shown to be significantly different for farmers by information search behavior, where low searchers relied on interpersonal and broadcast media. Semi-medium and low searchers have lower preference for TV, which is a broadcast media

and lowest preference for print media, which reflects their current information access patterns. This confirms the importance of targeting information through appropriate media.

Table 17. Preferences for information mediums (1=not preferred, 2=neutral, 3=preferred)

			High		Medium		Semi-medium		Low	
Preferred medium	**F**	**Prob>F**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Personal contact	1.98	0.1162	2.58	0.66	2.52	0.74	2.43	0.82	2.67	0.71
Mobile helpline	7.76	0.0000***	2.41	0.85	2.12	0.94	1.84	0.94	1.98	0.94
Mobile voice	1.97	0.1175	2.26	0.84	2.13	0.89	1.92	0.93	2.13	0.93
Formal education	1.23	0.2962	2.22	0.71	2.06	0.79	2.16	0.83	2.11	0.91
Informal education	1.36	0.2539	2.14	0.73	2.08	0.81	1.98	0.88	2.21	0.91
Print media	10.42	0.0000***	1.99	0.85	1.74	0.83	1.92	0.95	1.48	0.77
TV	4.69	0.0030**	1.89	0.85	2.08	0.91	2.41	0.84	2.15	0.93
Mobile SMS	0.17	0.9143	1.66	0.83	1.67	0.86	1.63	0.86	1.71	0.88
Radio	0.29	0.8292	1.35	0.64	1.32	0.61	1.27	0.57	1.35	0.63
Electronic media	1.25	0.2911	1.25	0.51	1.21	0.48	1.14	0.46	1.16	0.44

*, **, *** - means significant at 0.10, 0.05 and 0.01 respectively

Source: Authors' calculation

4.8 Factors that influence farmers information search behaviors

The foregoing analysis already demonstrates that farmers differ in their information needs, sources used and preferred medium information access. In order to further understand the determinants of the high and low search behaviors, logistic regression models were estimated (Table 18). The high and low information search behaviors, defined using Ward's hierarchical clustering technique, were used as two separate dependent variables in two logit regression models. To determine the factors that influence high search behaviors and low search behaviors, the variables in Table 2 were used. This included the rice information need factors and the attitude towards information searching factors.

The characteristics significantly distinguishing high information search farmers are being a member of FBOs[1], holding APL card, and giving less importance to the rice 'production' information factor. Membership to FBOs suggests greater interaction with other farmers who may know about other sources of information and influence farmers access and use to information. Those who hold APL card suggest they have greater capacity to purchase information. Production information was shown to hold more interest for the low searchers as well. This variable is significant in both regressions although influencing differently.

The variables that significantly determine low search behaviors are membership to FBOs, cultivated area of land during Samba crop season, the attitude variables 'source problem,' 'ability,' and 'payoff' and rice information factors 'post-harvest' and 'production'. Not being a member of a FBO may reduce encouragement to seek information; while smaller cultivated land area may reduce incentive to seek information as risk taking capacity of the smallholders may be low. According to the model, low searchers have less problems sourcing information, but this may be because they rely on one or two interpersonal sources that are easily available. However, low searchers lack the ability to search for information, but see some benefit from using information. In terms of information needs, low searchers give less importance to rice 'post-harvest information,' but give importance to 'rice production information.'

[1] Membership in a farmer based organization could be endogenous. We tested for endogeneity of MEMFBO using the Haussmann specification test and found that the coefficient of the residuals of MEMFBO in the model not significant, indicating that MEMFBO is not endogenous and the logit regression model gives consistent and efficient estimates.

Table 18. Logit regression of high search category and low search category

	High information		Low information	
Variable	**Coef.**	**P>z**	**Coef.**	**P>z**
Male head	-1.19	-0.13	1.60	0.15
Age	0.00	-0.77	0.00	-0.94
No School	0.13	0.76	-0.05	-0.89
Member of FBO	1.43	0.0000***	-0.56	-0.097*
Cultivated area samba	-0.02	-0.40	-0.08	-0.06*
APL card	1.26	0.0000***	-0.24	-0.39
Agricultural income	0.00	0.32	0.00	-0.52
Distance to market	-0.02	-0.40	0.03	0.21
Source problem	0.24	0.10	-0.51	-0.001***
High search	-0.23	-0.12	0.14	0.30
Ability	-0.14	-0.46	-0.33	-0.08*
Payoff	-0.05	-0.78	0.29	0.09*
Search costly	0.13	0.44	-0.02	-0.93
Post-harvest	0.20	0.16	-0.25	-0.07*
Production	-0.88	-0.0000***	0.86	0.00***
Protection and fertilizer	0.36	0.11	-0.14	-0.59
Finance	0.17	0.21	-0.08	-0.60
_cons	-0.74	-0.67	-2.71	-0.18
	Number of obs =471		Number of obs=471	
	LR chi2(17)=98.08		LR chi2(17)=86.98	
	Problem>chi2=0.0000		Problem>chi2=0.0000	
	Pseudo R2=0.1767		Pseudo R2=0.1573	
	Log likelihood=-228.45		Log likelihood=-233.03	

*, **, *** - means significant at 0.10, 0.05 and 0.01 respectively

Source: Authors' calculation

4.9 Willingness to pay for voice-based mobile information

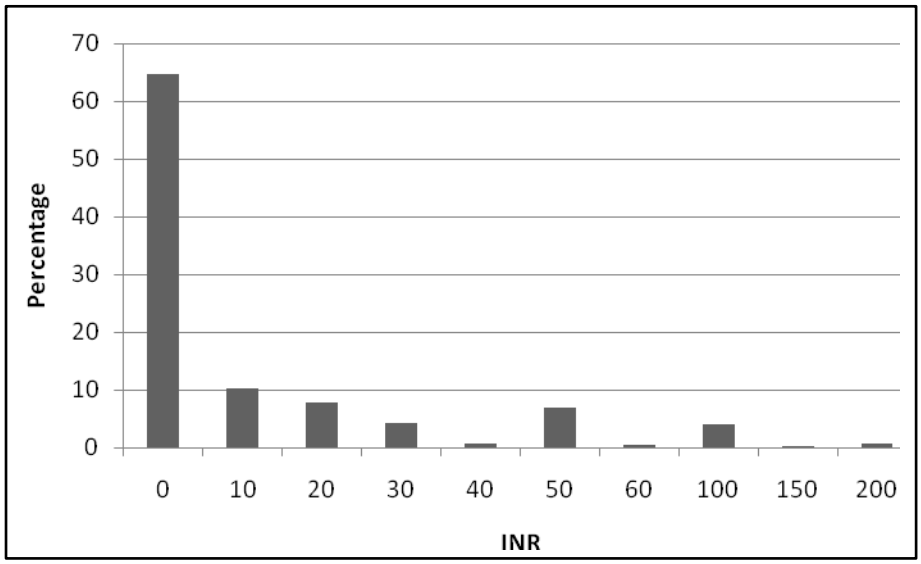
The number of agricultural interventions that disseminate information via ICTs is increasing. In India, these include the private initiative of Thomason Reuters, known as Reuters Market Light, which delivers SMS to farmer mobile phones with price, weather and agro-advisory information. IFFCO-Kisan Sanchar Limited (IKSL) is another program, which is a partnership between IFFCO and Bharti Airtel. Farmers receive 5 free daily voice messages to their mobile phones when they purchase a

'Green' Airtel SIM card, with agro-advisory based on crop zones. The Kisan Call Centre is a toll free mobile phone helpline from the Ministry of Agriculture, where farmers can speak directly with experts about any queries they have. The spread of these programs is increasing across India. In the study area, IKSL has been present since 2008 with about 2,000 subscribed farmers in Thanjavur district today.

Delivering agricultural information via mobile phone may be a useful and timely method of delivering knowledge and information to farmers. Already the farmers in the survey preferred medium were mobile phone voice and a mobile phone helpline, after personal contact (Figure 11). In the FGDs, farmers preferred voice-based messages via mobile phone over SMS due to literacy limitations. The majority of respondents owned mobile phones in the study area (83%), more in Thanjavur (89.3%) than Tiruvarur (76.3%). The average number of mobile phones per household was 1.3. The main service provider in the districts was Aircel (30%) followed by Vodafone (19%), Airtel (13%) and BSNL (13%). Only 3.0% of mobile phone owners accessed agricultural information via mobile phone. These messages mostly related to market prices and pesticide application. In comparison to computers and radio, mobile phone ownership was far greater. About 14.8% respondents owned a radio, and only 7.7% listened to agricultural programs on radio, on a daily or weekly basis. Only 3.5% respondents owned a computer, and 1.4% accessed the internet.

To gauge the value farmers would place on agricultural information delivered via voice-based message, we asked respondents their willingness to pay for a month voice-based mobile phone message. Figure 10 shows that most of the respondents were willing to pay nothing, as they thought the information should be free (59.2%) or should be provided by the government (10.5%).

Figure 11. Willingness to pay (WTP) for voice-based mobile messages



Source: Author's calculation

By information search behavior, willingness to pay differed significantly (Table 19). High searchers were willing to pay the highest amounts, followed by semi-medium, and then low searchers. Medium searchers were willing to pay the least for the service.

Table 19. Willingness to pay by search cluster

WTP	***High***	***Medium***	***Semi-medium***	***Low***
Mean (INR)	19.25	9.83	13.25	12.88
SD	36.55	19.90	22.69	29.96
F=2.81, Prob>F=0.0391				

Source: Authors' calculation

To understand the factors that influence farmers WTP for information sent via voice-based mobile phone, an ordered probit model was specified and estimated (Table 20). The significant factors that explained farmers' willingness to pay for information include membership to FBO, use of extension, cultivated land area during Samba, APL card, and distance to market.

Membership to FBO increases likelihood of farmers' willingness to pay for mobile voice-messages. Perhaps belonging to an FBO, awareness of mobile-based services is greater, and the potential convenience of access and timely availability increase WTP. As more information sources are accessed by farmers, their likelihood of willingness to pay for information through mobile phone decreases, which may be because sufficient information is already available to them (though this contradicts high searchers WTP which is highest, but is reflected by medium searchers lowest WTP – Table 19). As expected richer farmers whose area of land cultivated and who hold an Above Poverty Line (APL) card have higher willingness to pay. This may be because their capacity to pay is greater. As distance to market increases, WTP decreases. This may be because mobile services are less accessible and network strength is weaker as the farmer lives away from market center and so WTP for mobile phone messages is lower.

The results show that WTP for mobile phone messages is not high. For example, the WTP was less than the subscriptions charged by the Reuters Market Light Company. This is not very encouraging considering the increasing number of projects pushing agricultural information via mobile phone. However the Kisan Call Centre, a toll free number for farmers to reach experts, could be valuable for farmers as mobile phone is preferred medium for many. But the focus group discussions found that the Kisan Call Centre performance was poor in terms of the response rate and connectivity.

Table 20. Ordered probit regression model for willingness to pay for information

WTP	***Coef.***	***Std. Err.***	***P>z***
malehead	0.428	0.643	0.505
age	-0.008	0.005	-0.135
noSchool	0.123	0.216	0.570
memfbo	0.322	0.155	0.038**
Number of information sources	-1.908	1.121	-0.089*
cultsamba	0.028	0.011	0.013**
apl	0.338	0.156	0.030**
aginc	0.000	0.000	0.850
distmark	-0.024	0.013	-0.072*
/cut1	-2.867	2.216	
/cut2	-2.562	2.216	
/cut3	-2.281	2.220	
/cut4	-2.102	2.220	
/cut5	-2.067	2.221	
/cut6	-1.580	2.211	
/cut7	-1.535	2.216	
/cut8	-0.710	2.195	
/cut9	-0.591	2.177	
Log pseudo likelihood = -519.24194			
Prob > chi2=0.000, Pseudo R2=0.0426			

*, **, *** - means significant at 0.10, 0.05 and 0.01 respectively

Source: Authors' calculation

5 Discussion and policy implications

Understanding what information farmers need, how they search for their information, which sources they depend on for accessing information, and how much they are willing to pay for such information can help in designing effective extension programs and advising services in developing countries. This study examined the information search behaviors of farmers in southern India, and confirms the heterogeneity within farming communities of this behavior. The results of this study can support targeted extension programs in the area. The main outcomes and implications of the study are discussed below.

Information search behaviors

As increases in productivity of smallholder agriculture crucially depend on their information related to production, processing, and markets, identifying their sources of information and search behavior becomes important. The provision and targeted delivery of agricultural information to small and marginal farmers remain a challenge in extension programs (Swanson 2008; Swanson and Rajalahti, 2010). The results of this study show that the low information searchers had smaller land holding size, lower level of education, and lower standard of living. Their information needs and crops also differed from the other search categories. Low searchers required information on crop practices and credit availability, and required information on less water intensive crops like black gram and other gram. The low searchers used a fewer number of information sources, and less frequently. The main sources of the low search behaviors were interpersonal - the input dealer, the state department of agriculture extension staff, family and progressive farmers. The results clearly show that to reach low information search farmers requires different delivery and content strategies in extension programs. Formation of farmer-based organizations and farmer groups are often encouraged to reach these farmers (Swanson 2008). This is supported by the results, where membership to FBO was associated with high search behaviors. In India, formation of farmer groups is the current approach of the national public-sector agricultural extension program called Agricultural Technology Management Agency (ATMA). Considering the already high use of state department of agriculture extension staff by the smallholder farmers in the area, the state department of agriculture could take further initiative to facilitate formation of farmer groups, including women's farmer groups. However organizational performance issues in the public sector extension system, which came out in the FGD, may need to be overcome for successful formation of such groups.

Most used information sources and preferred medium

Agricultural extension and advisory services in India are pluralistic. The results from the study show that farmers' access information from a range of sources, but this in turn depends on their information search behaviors. Despite varying search behaviors, almost all the farmers in this region are already

seeking information from one source or another. The results indicate private input dealers, state department officials, local farmer cooperative banks, newspapers, and television are the most used information sources of farmers.. Interpersonal methods of information sharing are the most preferred mode of dissemination. The results of this study differ greatly from the NSSO 2003, which found 60 percent of farmers did not access any information on modern technology to support their farm enterprise (NSSO, 2005). To improve extension coverage, sources like the state department of agriculture, the agricultural cooperative banks, newspaper and TV could be targeted as appropriate sources for delivery of information. The current challenge however is to provide relevant, appropriate, and contextualized content for various agro-ecological zones. Information needs to be provided in local languages. The heavy reliance on the private input dealer is of concern considering the conflict of interests inherent in this service. Given that the main information needs of the farmers relate to pesticide and fertilizer application and pest and disease management, training and capacity building of private input dealers on specific crop pest, diseases, and other crop management methods would reduce misinformation and exploitation of poor farmers who depend on both information and credit from the input dealers. Complementing this approach by establishing more agriclinics, which is a private owned but public subsidized program to encourage trained individuals, would help in creating a competitive environment for agricultural information sharing (Global Agri System, 2008).

Mass media, ICTs, and Willingness to pay

Information and communication technologies are increasingly highlighted as a valuable and efficient way of providing information to farmers (Richardson, 2006a; 2006b). The high search farmers in the study area already use newspapers, and TV is a key source of information for all the farmers, including the low searchers. The newer technologies, like internet and mobile phones are currently under-utilized to access information in the study districts. Despite high mobile phone ownership, access to information via mobile phone was low. The contingent valuation exercise showed that fee-based delivery of information via mobile phone is not in high demand. This may inhibit penetration of private approaches like RML or IKSL, but the Farmer Call Centers currently implemented by the government may become a valuable information source. However, the performance of the Farmer Call Centers has to improve, as the FGD showed that accessing information from them was problematic. Despite this, farmers would prefer to access information via mobile phone, after interpersonal sources, suggesting that mobile phones could be a useful way to reach farmers, provided the service is freely available. The role of public-private partnership in the provision of agricultural information needs to be explored further in this context.

Information needs

Inappropriate or poor quality information could be a hindrance to farmers' use of information sources. However in this study the information accessed was relevant most of the time. The major constraints to information access are poor availability, poor reliability, lack of awareness of information sources available and untimely provision of information. Improvement in the service delivery of information seems to be more relevant than improving the content of the information. This relates back to the already mentioned organizational performance of the public extension system, which needs to improve its timely delivery of information. Awareness creation through newspapers and television of the different sources of information farmers would also be helpful. In addition, the use of a public notice board in a public space, like the village tea shop, would be a useful place to begin, as the value of this space was highlighted in many of the focus group discussions. The decentralized "panchayat" administration system in rural India could be connected to information dissemination in agriculture there by increasing the returns to public information from the agriculture sector.

6 Concluding Remarks

In the recent decades, the value of information has increased considerably as the agricultural systems in developing countries become knowledge-intensive. Access and use of current information is critical for not only financial success of farmers, but to support sustainable agricultural systems. Yet, farmers are rarely consulted before the design of extension services about their needs and preferences. But by understanding farmers' access to and use of agricultural information, their agricultural information needs, and the factors that influence this behavior, programs disseminating agricultural information could better target farmers. The findings from this study have important implications for agricultural information dissemination that the public extension system and other programs carried out in developing countries. Targeting small holder farmers, with low agricultural income, is important as they search for less information. These farmers may lack motivation and interest in agriculture, so improving the timely delivery and reliability of information will be important to encourage small landholder farmers to improve their information search strategies and consequently could have important farm outcomes. Information needs of farmers could be targeted according to the farm characteristics, and channeled through their preferred medium. Further research is needed to explore the organizational performance challenges in the extension approaches that are restricting timely delivery, appropriate availability and reliability of information to farmers. While this study highlights strong heterogeneity within a similar rice farming system in Tamil Nadu, greater understanding of the differences in farmer information strategies across states and farming systems of India is needed.

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