What is Information worth for an extra quintal of grain?
Randomized Experimental Evidence from Farmers in India

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What is Information worth for an extra quintal of grain?: *Randomised Experimental Evidence from Farmers in India*

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Abstract

This study evaluates whether access to real-time customised idiosyncratic agricultural information over extended seasons improves the value of such information among farmers. We conduct a controlled randomised experiment in the Indian state of Karnataka. The study employs the difference-in-difference method to a panel of households comparing the differential valuation of information during the post-intervention period between treatment (participant) and control (non-participant) farmers relative to the outcomes observed during a pre-intervention period. We find robust evidence of the intervention showing significantly positive impacts on the valuation of agricultural information among treatment farmers relative to the control farmers. A difference of each one unit improvement in information access is found to be associated with 53 percent average increase in the mean valuation of the information. The result indicates that farmers value information that is comprehensive, reliable, real-time and idiosyncratic as opposed to the more generic or piecemeal information.

Keywords: Agriculture, Information, ICT, RCT, Learning, Productivity
JEL: D83, O13, Q12, Q16

INTRODUCTION

Starting with Adam Smith, economists have arrived at a consensus that information availability (access) is both costly and valuable component of efficient markets; "knowledge is power" (Stigler, 1961:213). To overcome the perceived information failures in agricultural sector, many governments have long been producing and distributing information on appropriate agricultural practices to farming community for technology adoption and to impact agricultural productivity. Such publically provided information is an ongoing effort of governments in developing countries to assist farmers to become more productive and efficient (Maffioli et al, 2011; Just et al. 2002). While various innovations such as the Farmers' Helpline are made available to make such information effective, however, serious concerns remain about the delivery of information valued by farmers. Increasingly, additional sources of information than solely relying on publically provided information services are given emphasis to diffuse information on agricultural technology and farm practices to streamline the agricultural development process[1].

The reason for emphasis on alternative efforts on information supply is mainly due to the weak adoption of improved practices in developing countries, which is well documented (see Aker, 2011;

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[1] In the context of structural and organisational change in agriculture, explosion of information technology, growing sophistication of farmers and decision-makers, problem of incentives of public servants for accountability to farmers, weak evidence of impact and shifts in conceptions of the appropriate role of the state in the economy, some have questioned the role of public and private sector actors in providing agricultural information services (Waddington et al., 2014; Aker, 2011; WDR, 2008; Anderson and Feder, 2007; Just et al., 2002).

Dinar, 1996). There are increasing numbers of theoretical and empirical literatures to explain the determinants of adoption of agricultural technology in different context. Economists have developed a framework to study the value of information in specific farm activity contexts. Typically, farm outcomes in the absence of information are compared to farm outcomes when information is available to estimate the value of information. Also, typically, studies analysed the value of a single or generic set of information to farmers, when each of whom might have different information need as well as uncertainty faced by the individual. (e.g. – see Suri, 2011 and others in Aker's, 2011; Anderson and Feder's, 2007 review of economic literature on agriculture extension).

While the findings differ in the existing literature according to the type of information and context, the key measure of value of information is focused on production. The mixed evidence on the efficacy of the farm information makes it difficult to ascertain whether it is due to the differences in the mode of information dissemination or methodological challenges associated with evaluating information programme without plausible exogenous variation (Aker, 2011; Birkhaeuser et al., 1991). It has become clear that we continue to lack the basic understanding of patterns of use of information by the economic agents, the roles of different types of information and individual's attitude and aptitude towards learning and application of information.

In this paper, we examine a hypothesis that display of low yields, or unscientific practices after information bundle is provided are not outcomes of subjective bias attributed to prior poor agricultural practices or learning failure. This is not an improbable proposition given that farmers face many different types of uncertainty. Yields may fluctuate due to unfavourable weather, pest and disease problems, political economic factors such as labour markets and trade regulations (Just et al., 2002). Farmers may learn, value and appreciate the significance of the agricultural information that need not necessarily always result in higher yields. Hence, examining yield outcomes to evaluate farmer's learning, as done by some recent studies, may not always be appropriate (for example, see table 2 in Aker, 2011 for compilation of such studies). Using the field experiment, we ask if better valuation of information by economic agents (farmers) is thought to make up a large share of the learning return, which many a time might not reflect in farm outcome, such as yields or pattern of use of information captured in agricultural practices. Can we estimate the farmer's valuing of information conditional on his ability to acquire and process information (knowledge) as a proxy of learning effects or a critical determinant of economic performance?

It is useful to give an example to demonstrate the line of thought from our experience with paddy farmers in South of India last season in 2014.

> *'Though many varieties of rice exists, a paddy farmer in a rain-fed area of Southern India makes plenty of investment by sowing new variety seeds in the season to reap high returns on it. The new variety seeds supported high yields and were also equipped with an adaptation measure to deal with limiting water resource. Nonetheless, farmer's expectation to reap high yields depends on many features of cropping cycle in the season. One of the important criteria for regulating rice plant growth and yield is the age of seedlings at transplanting. A farmer, knowing that he is supposed to transplant young seedlings between 12 to 15 day old, as the yield declines of older seedlings, chose to transplant more than 55 day old seedlings. This farmer made choice between loosing entire investment of the season or reconcile with sub-optimal rice yield. The argument of 'to do it right' by him required sufficient depth of water management soon after transplanting. The farmer faced delayed rains in the season. He delayed transplanting which primarily has to be attributed to water shortage, or climate change, than it has to do with his knowledge grasping. This farmer, and many in the sample, is likely to be served with low yield. In gist, farmer had learnt to lay foundation for determining plant growth and yield but could not practice it'. (Based on authors' experience in field experiment, August 2014)*

Table 1 presents more of such selected field-based observations that were found prominent than others to indicate issues likely to affect yields despite the use of additional information/learning to reduce uncertainty and increase yield outcomes. Table 2 presents the field observations to indicate incorrect farm practices that were addressed in tailored-way through treatment intervention. The two tables distinguish in terms of importance of the information packaging both to impart right knowledge and to manage shocks in real time, while both having effect on growth dynamics and overall yield potential. The potential impact of having access to better information on agricultural productivity, output prices, economic growth and poverty alleviation have been discussed in different contexts, this study, for the first time, utilizes a randomized control field experiment and surveys before and after the experiment to investigate the impact of ICT-supported real-time comprehensive agricultural information on treated farmers' valuing of the farm information in the Indian state of Karnataka.

More specifically, to examine our hypothesis in this paper, which is a part of large project theme, we evaluate whether exposure to intensive agricultural information over extended seasons improves the value of information among treatment farmers to reflect gains from the educational intervention. The presence of uncertainty in the farming sector, either due to weather or market, lead farmers to value information that is comprehensive, real-time and idiosyncratic as opposed to the more generic or piecemeal information provided in some recent experimental studies. For example, farmer would want information to use crops that will resist the extremes of weather, particularly crop varieties that are more tolerant to weather variations, and lower levels of inputs than would be optimal in a predictable world because of the risk of losing the investment altogether (Timmer et al. 1983). In view of it, yield outcomes might not always reveal the significance of learning from extension services.

Studies also suggest that there are temporal dimension of extension services (Maffioli et al. 2011). 'How valuable information is depends on the context: because information is not useful in one year does not imply that it is never useful' (Fafchamps and Minten, 2012:10).

Table 1: Field Issues likely to interfere with treatment intervention outcome

S.no	Problem / Issue	Reason	Suggestion to deal with problem
1.	In Paddy cultivation – transplantation of aged seedlings (>55days)	Delayed monsoon and water shortage in Tungabhadra river hampered transplanting detrimentally.	In order to encourage the tiller production – split dose of fertilizer needed- Basal N application of 50% of the recommended dose.
2.	In Paddy, appropriate row-to-row and plant-to-plant spacing was not maintained.	Due to shortage of labour, farmers gave contract based transplanting on area basis (Rs 2000/ac). Contractor and his team completed the transplanting with wider row-to-row and plant-to-plant spacing (20-25×20-25 cm) for quick coverage of the area. For short, long duration variety' and even aged seedlings also. Correct Spacing (cm): Short-15×10, Medium- 20×10 and Long- 20×15	Project's field staffs suggested requesting the contractor for transplanting with proper spacing and to adhere to planting instructions.
3.	Pests migrated from farmer's adjoining unsprayed field to his healthy field.	When neighbourhood farmer did not spray or maintained the plants properly in his field, pests migrated from unattended field to treated farmer's field because insects have preference towards healthy crops.	For that, adding Azadirachtin (neem formulation) 2ml/lit along with chemical insecticides for insect repellent action was suggested.
4.	Untimely fall of cotton square in the healthy plants.	The year (2014) received off-season rainfall, which was in the flowering season. As a consequence of it, most of the cotton squares dropped from the	Project's field staffs suggested to spray 2 kg of DAP, 1 kg all 19 (19:19:19) along with

		plants.	70ml of planofix for an acre (NAA) for controlling the further shedding of flowers and increasing the boll setting.
5.	Obtaining agricultural chemical on credit from the local chemical shop affected the treatment intervention. On occasions when the recommended chemical is not available, treated farmers are given some other local branded chemical as a replacement which not necessarily was suitable.	Money problem: most of the farmers are not in a position to purchase chemical by direct cash payment.	Field staffs not only recommended the sprays but also provided information on the reliable outlets to buy them with explanations about problem (binding constrain) under credit purchases
6.	Similarly, yield difference exist between irrigated and rain-fed cotton fields	Non-availability of water in major critical stage of cotton crops *viz.*, germination, flowering and boll formation stage affects yield optimization.	Consistent Problem

Source: Field Experiment, 2013-2014

Farmers need adequate cognitive space and time to make the best decisions for themselves before they adjust to new information and apply them in their agricultural practices (WDR, 2015). Akerlof and Kranton's (2000) incorporates psychology and sociology of identity into an economic model of behaviour and describes that unobservable factors such as the pattern of learning support preferences and constraints stemming from farmer's own social identity also play key role in influencing farmer's decision-making behaviour.

Table 2: Widespread incorrect farm practices that were addressed in tailored-way through treatment intervention, besides providing customised extension services

S. no	Problem / Issue	Reason	Advice to deal with problem
1.	Farmers do not apply Phosphate (P) fertilizer in paddy and cotton crops as basal dosage. 'P' fertilizer is very essential for earlier stage of root establishment in all the crops Based on soil test report, undertaken in the project, 75% of soil in the study area is deficient in 'P' content.	Lack of awareness about 'P' fertilizer	Project's field staffs explained to the farmers both the usefulness and timing of application of 'P' fertilizers. A change is observed amongst the farmers and farmers started using (P) during the basal preparation.
2.	In paddy fields, farmers tend to overlook basal dose of fertilizer which is related partly to their financial problem.	It is found that farmers tend to spend good share of their cost in land preparation, nursery preparation, seedling transportation and transplanting. However, they face money-shortage at the time of transplanting preventing them to invest in fertilizers.	Project's field staffs explained usefulness of right use of the fertilizers during basal to the farmers and also accessing Kisan Credit card to address some of the financial problems i.e., to be able to purchase farm inputs at the right time of cropping cycle.
3.	In paddy , field- to-field irrigation is the most common practice in the study area. This has dangers of spread of pests and diseases and leaching of fertilizer.	Lack of awareness among the farmers	Project's field staffs explained pitfalls of such practice and helped to install separate pipe line for individual field for discrete irrigation channel.
4.	Water stagnation in cotton field is one of the commonly witnessed problems in the study area. It is not	Heavy rainfall and improper drainage facilities lead to waterlogging in the fields.	Project's field staffs advised farmers to create proper drainage facilities to avoid further damage. For quicker

	good as cotton is moister sensitive crop and moisture affects the yield quality. Water stagnation affects aeration in root zone of the cotton. As a result, roots are unable to uptake the nutrition from the soil directly affecting the yield quality.		recovery, the treatment experts suggested the use of foliar spray of 2 kg of DAP and 1 kg of All 19 (19:19: 19) @10 days interval.
5.	No proper row-to-row and plant-to-plant spacing is maintained in chilli and cotton crops. Farmers tend to maintain >120-130 cm row-to-row spacing, which is waste in land usage.	It was found that farmers use blade harrow (kunttae) implement by using animals for weed management. This practice makes them to maintain wide spacing between rows.	Here Project's field staffs recommend 120 X 45cm spacing, so that row-to-row weeding can be carried out with the help of implement and plant-to-plant weeding can be done as hand weeding. This allows increasing the plant population and thereby increasing the yield.
6.	Improper thinning of chilli.	Lack awareness of the farmer/incorrect understanding.	Project's field staffs explained the benefits of thinning. Also, field demonstration (1m^2 area) was carried out to facilitate the learning.
7.	Farmers tend to apply more than two chemical for single group of insect pest. It leads to increase in cost of cultivation as well as insect resistance and environmental pollution.	Misguidance by pesticide dealers/ lack of awareness among farmers**.**	Project's field experts explained about use of right chemicals and provided tailored dose in a printed slip to the farmers.
8.	Unchecked usage of growth-promoters by farmers due to misguided advice of pesticide shops- for their own benefit. This leads to increase in the cost of cultivation.	Misguidance of pesticide dealers/ lack of awareness among farmers how to use plants growth promoters or untimely shedding of flower.	Suggested the foliar spray of 2 kg of DAP, 1 kg all 19 (19:19: 19) and 70 ml of planofix in an acre (NAA) for controlling the flower shedding and boll development.
9.	Inappropriate selection of crop (i.e. unsuitable crop selection in relation to type of soil/area).	Due to the high market prices of cotton in previous harvest year (last year), most of the rice producing farmers switched to cotton farming. Farmers, thus, cultivated cotton on low land area, shallow soil and stoned soil. Cotton needs deep black soil with high fertility by nature because cotton crops are long deep rooted crops (>90cm)	Project's field experts advised to create proper drainage facilities to reduce excess water in the soil. For quick recovery, the foliar spray of 2 kg of DAP, 1 kg all 19 (19:19: 19) @10 days interval was suggested to reduce flower shedding and improve boll development.

Source: Field Experiment, 2013-2014

In our randomized field experiment, farmers' valuing of information might reflect gain in new farm learning and acceptability of additional information service. However, literature suggests that in practice, valuing of information (willingness to pay) for farm information service has been slow to emerge in many settings (Anderson and Feder, 2007, 2004). This could also be true in context of India. Almost all the services provided by public sector extension have been traditionally free as achieving food self-sufficiency through agricultural development has been a public goal. The strategy of private benefits farmers derive out of it was never considered as a means to generate resources for the service provider. Moreover, extension was considered as some sort of public education and making it available free at the field level has been the accepted strategy to make farmers adopt the promoted technologies. In 2010, the government of India spent $300 million on agricultural research and a further $60 million on public extension programmes (RBI, 2010, cited by Cole & Fernando, 2012).

It may seem that this backdrop makes the research experiment challenging[2]. However, the evidence from a recent nationally representative survey shows that just 5.7% of farmers report receiving information about modern agricultural technologies from public extension agents in India (Glendenning et al., 2010). There are other subjective behavioural choice challenges that we foresee in affecting valuing information. Even if model delivers information in real-time; significantly improves development outcomes such as low-costs higher yield, greener ways of pests control, and also holding potential of building capacity among rural people to identify and take advantage of available opportunities both technical and economic over the time– (empowerment model in contrast to prescribed delivery model), whether or not it is a worthwhile investment from the perspective of a resource-constrained household is uncertain for a number of reasons. First, information service is designed to be productive and preventive from the land preparation until post-harvest management, not remedial (damage control). Will households choose to invest limited resources in a 'farm management concept' before a farm exhibits signs of crop loss at a stage of crop production/ crop cycle? Related, will household value information service when many of the short-run effects, such as improved soil micro-nutrients restored (or retained) and improved farm productivity may not be easily observable to or directly valued by households? Moreover, will household choose to invest in information service when many of the information is available locally by other sources, and would be able to foresee economic returns to improved farm management (beyond technical agriculture) after completion of crop cycles?

The primary data is based on continuous field experiment that administers the full crop cycle through in-person field visits, educational information and technical demonstration, supported by IT/web enabled tablet that contains best practice field management package, henceforth called as Dynamic Agricultural Tablet-based Extension Service (DATES). To our knowledge, determining value of information with respect to extension service through randomised controlled trials has not yet been studied in the literature. With odds in the background finely aligned with unique information experiment set-up, our preliminary findings of the intervention suggest significantly positive impact on the valuation of agricultural information among treatment farmers relative to the control farmers. A difference of each one unit improvement in information access is found to be associated with 53% average increase in the mean valuation for the information. We find that the level of hypothetical valuing of information varies significantly with cropping experience, land size, education and caste of the farmers. The study is expected to fill the gap in policy understanding that the household choices and the behaviour, such as the choice to invest in new agricultural technology, might be determined by information package which is comprehensive, real-time and contextual as opposed to the more generic or piecemeal information provided in some recent experimental studies.

The paper is organised as follows. Section 2 presents the conceptual model that describes how farm information service fit into a household's economic decision-making agency as a special case of learning identification. Section 3 describes the experimental tool, design and sample selection. Section 4 present balancing statistics and the empirical strategy, while Section 5 presents results and Section 6 concludes with discussion on further research using the experimental data.

CONCEPTUAL MODEL OF INTERVENTION

Heterogeneity of Information and information need

Skipping the technical details for now, from the established literature that features concepts of self-productivity and complementarity of human capital investments, together with learnings from endogenous growth model literature (Cunha et al. 2006; Huffman and Orazem, 2007; Huffman,

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[2] Farmers would not know that we look at his price assessment of the information service as an indicator of his learning. For him, it is an additional cost commitment based on the learning effects.

2001; Romer 1986; Acemoglu 2008), we formalize our understanding that formation for human capital (farmer's effort to complement his existing in-house information resources) has causal effect on subsequent growth outcomes.

Literature on the "information commerce" describes that information increases in value as it becomes more familiar, unlike physical goods that are more valuable if they are scarce. Information has no value in itself; its value is derived from its understanding and subsequent application (Barlow, 1994). For the farmer, the issue of appropriating the returns to investments in information and knowledge is thus central (Stiglitz, 2000). The model of bounded rationality suggests that individuals face limitations on their ability to use, store, or retrieve information (Simon, 1959). It is likely that difference in individuals' capacity to process and assess the value of information lead to variability in consumption pattern, as some individuals will have little ability to use certain information, and thus weaker demand. Schultz (1979) documents returns to human capital approach and recognises economic role for education and experience. He portrays the idea that difference in forms of people's ability to deal with disequilibria drives the variable performance under uncertainty. Hanna et al. (2014) developed the notion of learning failures by people with experience. While one dimension of the model demonstrated that experience and prior beliefs subconsciously inhibit the farmers to notice key aspect of production, another dimension highlighted the benefits of design of intervention to overcome loss from (under) inattention to data. Here, in the analysis, we position the concept of farmer's valuing information to deal with uncertainty through acquisition of additional information (Stiglitz, 1985, 1974), together with learning of bounded rationality models (Simon, 1959), role of human capital and experience (Schultz 1975, Hanna et al., 2014).

Given the atomistic nature of agriculture (Klein and Cook, 2005), we provide a continuous flow of demand-oriented real-time 'partially processed' information both through in-person visits in combination with web-enabled tablet to enrich the knowledge sharing experience and enabling easier use, store and retrieval. It is not one-off 'hit or miss' provision of supply-driven information. Since August 2013, the web enabled information experiment is administering crop-cycle season-wise in the two districts of the Karnataka state in Southern India[3]. In the paper, we therefore conceptualise that need for different type of farm knowledge under different uncertainty context in the agricultural sector imparts value to information. Here, the notion of value of information is understood in terms of the expected benefit from acquiring (using) the varying amounts of different types of information under uncertainty[4]. In the experiment, information may appear in variety of forms, depending upon a stage of the cropping cycle to specific individual. The paper does not explicitly assess the value of each type of information, but rather the customised information package and economic logic underneath it unlike previous studies in the literature.

Worth of the Agricultural Extension Services

The provision of agricultural extension services has been justified in the literature on both equity and efficiency grounds[5]. Agricultural extension is a mechanism by which information on new

[3] In the research set-up, agricultural information service is unique trial-based 'seed-to-seed' information service given to farmers in their farmfields through extension advisors. As noted earlier, we call it Dynamic Agricultural Tablet-based Extension Service (DATES). By design, it offers combination of interventions, including *real-time* technical advice throughout crop-cycle on (i) nutrient management; (ii) plant protection; (iii) crop agronomy and (iv) credit and insurance market, while mobilising *real-time* support and connecting farmers to agronomists and scientists at the back-end through an IT/web enabled tablet.

[4] While the conceptual framework developed in this paper is specific to accessing and processing agricultural information for expecting better agricultural outcomes, the idea is akin to Grossman (2006) where he explains non-market outcomes of education (i.e. besides higher incomes).

[5] Extension was found, in general, to be beneficial public activity. The early literature of the 1980s and 1990s provides evidence that extension has a direct and indirect positive impact on farm efficiency. Literature such as Dinar and Keynan (2001), Huffman (1978, 1980), Evenson (1997), and citations therein, provide ample evidence of the benefits associated with extension. Anderson and Feder (2003) highlights the efficiency gains from various extension modalities.

technologies, more effective management options, and better farming practices can be transmitted to farmers (Owens et al., 2003). Extension agents disseminate information on crop and livestock practices, optimal input use, and consult directly with farmers on specific production problems, thus facilitating a shift to more efficient methods of production (Dinar et al., 2007). Studies distinguish from the ones that focus on the microeconomics of technology adoption (see Foster and Rosenwig, 2010 for survey) with the others that discuses advice or purely e-consulting based service to impact farm production practices (such as Fafchamps and Minten, 2012; Gandhi et al. 2009; Feder et al. 1987). In this literature, studies set-up in developing country highlights monitoring problems in a principle-agent framework (Anderson and Feder, 2007). For instance, political capture leads government agents to deliver farm information services to elite group who is associated with the local government rather than to marginal farmers for whom 'incremental benefit of information may be higher'. Cole and Fernando (2012) notes government agents target 'easiest-to-reach farmers' to meet their performance quotas, and the problem of neglect of farmers in interior is also compounded by transportation infrastructure in rural areas of India. Agricultural extension is rarely provided to farmers through in-person visits on cyclical bases, and inability of farmers to follow-up on information delivered limits their scope and intention to adopt new technology (Ibid).

The main body of research on the effect of extension services relies on the estimation of production functions that include extension service as one of the inputs. In general, these studies find large positive rates of return on extension services (Birkhaeuser et al. 1991). However, in the absence of random assignment of extension services, the methodology in the studies is likely to provide biased estimates of the impact due to endogeneity of the decision to participate in extension services programmes. Among the few studies that randomly allocate extension services, Duflo et al., (2011) show that after extension service offered for six crop seasons in Western Kenya, only 27% farmers on an average use fertilizer. The study concludes that slow rate of adoption of fertilizer later was due to farmers having trouble in saving harvest income for future fertilizer use. Preliminary version of the same paper by Duflo et al., (2006) notes that while farm information matters, it only goes partly, and whatever information is provided seems to be forgotten fast and does not even get diffused in their own practice let alone to friends and neighbours. Though it recognises the importance of learning 'how to use fertilizer', it is not clear to us if a problem of knowledge to choose and use hybrid seeds or technologies other than fertilizers was also explored in the experiment. The narrative informs that seeds recommended by the Ministry of Agriculture government did not germinate leading to total failure of the experiment. The motivation for intervention in Duflo et al. study is mainly focused on fertilizer use, while a possibility of mis-aligned incentives cannot be ruled-out. Both incomplete (imperfect) knowledge and uncertainty have consequences on farmers' decision making behaviour (see Rakow 2010). Although such isolated interventions may cause bad outcomes, a complete extension service support throughout crop cycle might gain farmer's confidence (or fathom fears of neglect) supporting farmers to invest in useful agricultural technologies as observed in the context of India under our project reported in this paper. Hence it is not unlikely that failing to practice the use of right quantity of fertilizer at the right time has nothing to do with behavioural bias but is a result of incomplete intervention.

Cole and Fernando (2012) finds positive significant role of a mobile-phone based agricultural consulting service to address problem of imperfect information in agriculture in the Indian state of Gujarat. On the other hand, Fafchamps and Minten (2012), who study an impact of SMS-based agricultural information on farm outcomes in the Indian state of Maharashtra, finds no statistically significant effect of services on farm outcomes such as crop value added or likelihood of changing crop varieties and cultivation practices etc. during the study period. Both studies employ RCTs. While Fafchamps and Minten mention the spillovers issue, the other study does not discuss much on ruling out the possibility of spillovers across farmers in control and treatment group. Irrespective of the differences in findings of the studies, we do not see how authors cope with usual challenges to identify the treatment effect systematically that are associated with regard to use of mobile technology for the intervention. These include – selection bias, i.e., establishing a proper counterfactual group in the research, and controlling the spillover effects. With access to mobile phone, farmers are able to contact members of their social networks more easily, thereby intensifying the probability of inter-village spillovers. This can lead to 'broader general equilibrium effects, especially if farmers exchange production patterns, or marketing behaviour, and are concentrated within a specific geographic location' (Aker, 2011:644). Econometrics has limits resolving challenges specifically resulting from the weak framework of the RCT design in the information dissemination experiment. In this paper, we address these issues systematically that are either not or weakly addressed in the existing literature through designing of the intervention (DATES). We discuss the experimental design and description of our intervention in the next section.

There is also a large body of literature that does not use random assignment of extension services but use control groups of farmers and nonexperimental techniques to address selection bias. For example, Godtland et al., (2004) estimate effect of a farmer field school programme and a traditional extension programme on farmers' knowledge of integrated pest management practices. Using both regressions with controls and matching techniques, they find significant positive effects for both programmes. Feder et al., (2003) also studying farmer field school programme in Indonesia, do not find any impact on yields or reduction in the use of pesticide. On the other hand, using panel data approach for farmers from Zimbabwe and Ivory Coast, Owen et al.(2003) and Romani (2003) find a positive impact of extension services on yield, although note that this impact is neither present for all years nor for all the crops studied. Maffioli et al., (2011) using panel data from grape producers in Argentina, find a negative overall impact of extension service programme on yields and provide evidence of a positive average impact on the adoption of higher quality grape varieties. The study argues that it is reasonable to expect limited (or even negative) short-term effects and more significant positive effects once the adoption process is completed. None of these studies focus on valuation of information from farmers' perspective and there seems to be limited research on this topic for the case of agricultural extension services. We will exploit database generated from randomized field assignment of DATES in order to shed some light on the important issue of valuation of information as an alternative proxy of learning benefits of extension service under uncertainty. The design of the experiment overcomes many of the econometric challenges to identify the treatment impact often suffered by many of the ICT-based studies including both non-experimental and experimental studies based on mobile technology.

DESCRIPTION OF THE INTERVENTION AND EXPERIEMNTAL DESIGN

Experimental Tool, Research Design and Data

Salient Features of the DATES Intervention

In the research set-up, the agricultural information service is unique trial-based 'seed-to-seed' information delivered to farmers in their own farms by our specially trained and qualified extension advisors. The following are the key features of our DATES information service:

1. The agricultural extension advisor with individual motor bikes makes personal visits to assigned randomly selected treatment farmer's fields on a bi-monthly basis throughout the crop cycle. Each advisor is equipped with a unique IT/web-enabled handheld device – a tablet. These tablets contain a range of agricultural information with audio and video (animation of pest and diseases) that provides both written and spoken information in the local language. It also provides real time connectivity with the agricultural scientist in the local Agricultural Universities for help with new and undiagnosed pests and diseases.
2. The intervention provides wide-ranging information to farmers which are relevant for his business. The extension advisors visit the farms with the tablet that contains three main agricultural-based modules, such as: (i) nutrient management; (ii) plant protection; and (iii) crop agronomy. And, (iv) the DATES also covered information provision about agricultural credit such as government agricultural credit schemes, and help in tie up with bank to facilitate crop loan, and agricultural insurance information such as available government

crop insurance schemes and help in tie up with AIC (Agency Insurance Company)to facilitate crop insurance[6].

3. In the nutrient management module, information on crop nutrition and soil nutrition is provided. In the initial stages of the intervention in 2013, majority of the farmers have had already applied fertilizer in their field. Hence, we had to wait until the end of the Kharif season to collect soil sample to test and advise the farmers on the nutritional requirements of their soil[7]. For plant protection field issues, we used IT enabled interactive programme, named e-SAP (Electronic Solutions Against Agricultural Pests) that provide information to farmers in real time on pest-related problems on all the crops grown by the treatment group farmers[8]. The programme is developed and actively run by scientists at the University of Agricultural Sciences, Raichur (hereafter-UAS-R), Karnataka. The third module agronomy encompasses information on crop rotation, plant variety, irrigation and drainage, meteorology, and weed control. Last but not the least, intervention delivers information to farmers on government schemes on agricultural loan and insurance in addition to providing relevant information on the procedures to applying for these schemes.
4. Although, seven field crops are identified as the focus crop for the treatment in the study: Paddy, Ragi, Cotton, Redgram, Bengal gram, and Sunflower, we found during the field experience that there has been demand for information on various other field crops such as groundnut, pigeon pea, chili, sugarcane etc. For example, some selected farmers in the project sites: Siruguppa and Gubbi, cultivate groundnut and require information on that crop. Although we do not study the impact of DATES on all crops that a farmer grows, the project provided other demand based information.
5. The intervention also looked into the provision of treatment to the plantation in Gubbi. With the use of e-SAP and knowledge support of the Coconut Development Board, issue-based agri-information was also provided to coconut and areca nut growers in Gubbi. Note that analysis in this paper does not cover plantation crops; we show results based on field crops only.
6. If there is a problem in the crop, the extension agents will first try to diagnose it with the help of material in the tablet. Along with the diagnosis, the agents also suggest remedial actions with a paper printout of each prescription to the relevant treatment farmers. However, if he was not sure about the problem then he takes three photographs of the affected crop parts and field conditions from different angles and submits to the online server. The scientist at the back-end takes care of the issues. The solutions are uploaded in the server and the agent further communicates it to the farmer.

Thus, DATES is a complete 'seed-to-seed' treatment that fosters conditions for inclusive productivity growth with the provision of real-time information on agricultural technology, solution and communication. It provides combination of interventions, including better technical advice on production process, especially on the use of variable inputs (including water), with the objectives of

[6] Two of the important information needs that remain unmet through DATES relate to providing Livestock production information and post-harvest price and marketing information services. While the team identified farmers' requirement of information needs for the whole agricultural value chain and planned towards it, the DATES model could not pursue it and had to limit the informational scope to on-farm production activities, credit and insurance due to certain practical challenges of the project implementation.

[7] The crops are broadly divided into three season-wise categories, namely, kharif, rabi and summer crops. The kharif season starts from June and ends in September. The rabi season is during October to February and the summer season is between March and May. The kharif season begins from the onset of the south-west monsoon and ends in September (autumn). The rabi season starts with the onset of north-east monsoon in October. Many crops are cultivated in both kharif and rabi seasons. The agriculture crops produced in India are seasonal in nature and highly dependent on these two monsoons.

[8] Paddy, Ragi, Cotton, Redgram, Bengal gram, and Sunflower are the focus crop of the treatment

increasing the efficiency of the methods of production, encouraging the adoption of new technologies and providing integrated agricultural information service to monitor plant health.

Research Sites in Brief

The DATES experiment is currently under progress in two of the talukas in two different agro-climatic districts of the Karnataka state in Southern India, wherein controlled trial has been going on for season-wise crop-cycle since August 2013. The experimental sites are (1) Gubbi taluk in Tumkur district and (2) Siriguppa taluk in Bellary district. Together, the study region is spread over two different agro-climatic zones with different crops grown, making the study broad and interesting. Gubbi comes under the Eastern dry zone, whereas Siriguppa falls in the Northern dry zone. In the Northern dry zone, the annual rainfall ranges from 464.5 to 785.7mm. About 52% of the rainfall is received in the months of September to December. So, Rabi is also a prominent agricultural season in Siriguppa. The soils are shallow to deep black clays in most areas. In Siriguppa, paddy is the major crop, followed by cotton. The annual rainfall in the Eastern zone ranges from 679.1 mm to 888.9 mm. More than 50% of it is received in pre-monsoon and monsoon seasons. In Gubbi the soil are red loamy in most areas and finger millet (ragi) is the major field crop followed by red gram.

Sample Size Calculation and Data Sample

Each of the farmers' groups is drawn from randomly selected 12 Gram Panchayats (the lowest tier of Rural Local Self Government) located in both project sites[9]. See the map in *Appendix A(i-iv)* for a geographical overview and classification of GPs in the study sites. The selected GPs are split equally between (six) control group GPs and (six) treatment group GPs separately in each district. While the choice of the taluka in each district was driven by pragmatic concerns, the sampling approach within the taluka was designed to yield a sample which is representative at the taluka level and at the same time, it curbs possibility of contamination of control. The sampling strategy ensured that no treatment and control GPs are next to each other, which was complimented further by the idiosyncratic intervention design. Using the 'tablets' for intervention carefully addresses the problem of selection bias, and sequence of tailor-made treatment to randomly selected individual farmers spread over a wide area of the GPs (in contrast to the villages) in the study site reduces the challenge of knowledge spillover from treatment farmer to control farmer.

According to the sample computations, there are 300 farmers each in control and treatment group in both project sites. The farmers are selected in equal numbers across all GPs[10]. Thus, for each GP,

[9] Two-stage randomisation procedure was adopted. The number of GPs in a district typically is around 30.We decided to select 12 GPs randomly in each district (Taluka) to ensure adequate representation of variations at the GPs level. At the first stage of randomisation, 12 GPs were randomly chosen from the total GPs. Then, selected GPs were split equally into control and treatment groups, using randomisation process. A constraint was imposed on randomisation viz. none of the control and treatment GP should be neighbours, to prevent flow of information from treatment GP to control GP, and a possible contamination of control farmers. We used Taluka level map with GP boundaries, to take care of this issue. After some trials, we got a sample, which suffice the constraints and we finished the process. Random number generation was done in excel.

[10] To elaborate on the sampling approach, sample size was calculated with adequate significance level and statistical power in order to ensure the minimum expected difference between means (or effect size) in two groups: control group and the treatment group for our project sites, following the standard formula: $n = 2s^2 \left[\frac{Z_c + Z_p}{\Delta}\right]^2$. In the formula, s demotes pulled standard deviation of both comparison groups, z is the standard normal variate, Z_c and Z_p are the values for desired significance level and statistical power respectively, and Δ is the minimum expected difference between means in two groups (or effect size). We computed crop specific and site specific sample size and made educated assumptions to arrive at a statistically significant effect size. Frontline demonstration (FLD) records were considered to fix the effect size to be tested statistically. FLD trials demonstrate the productive potential of newly released technologies in real-life farmers' field conditions and point out to the yield gap between farmer's current practices and an intervention. Based on the district-wise Frontline demonstration (FLD) records, an effect size of 10% increase in yield seems a reasonable choice under the project. Based on layers of calculations for sample computations, team decided

50 farmers are surveyed. To measure intra-GP spillover effect, 10 additional farmers in each treatment GP was included in the survey. Although they are in the treatment GPs they did not receive any treatment in the project. The idea behind having this group is to capture and measure any spill-over if at all from the treatment. Thus, the study sample constitutes 660 individual farmers (300 control group, 300 treatment group and 60 spill-overs) separately for Gubbi and Siruguppa taluk.

In summer 2013, we completed the baseline survey in Gubbi and Siruguppa. Detailed information was collected on agricultural activities, other economic activities such as livestock and dairy, other local or external source of agricultural information such as social networking indicators. The questionnaire-based survey also collected information on options chosen by farmers from three price bundles in India Rupees (300, 150, and 100) to reflect the valuation by farmers of the DATES service. During the baseline survey the team decided to get farmers response on a wide range of prices to get variation in the data. In Gubbi, three new price sets were introduced: {300, 200, 100}, {250, 150, 50}, and {200, 100, 50}. In Siruguppa, three different price sets were used: {500, 350, 150}, {400, 250, 100}, and {300, 200, 100}. The higher price bundles in Siruguppa were determined through a pilot survey and focus group discussion which revealed that farmers on average were willing to pay a higher price for the same services compared to Gubbi.

The post-treatment data on the farmers' valuation of DATES was collected by an enumerator in local dialect over the telephone who never met the farmers personally. This was to limit the bias in the farmer's response arising from the presence of the extension agent who had built the trust with the farmer over the seasons. See a note in *Appendix B(i-ii)* on salient observation, concerns during designing of the experiment and a translated script of telephonic conversation to elicit price choice of farmers.

The information on the valuation of DATES was inferred through stated preference to understand the learning dimensions of the DATES services, rather than using the information for understanding optimal pricing policy for the purpose of financing the service. Many of the pricing studies debate over lack of revealed preference information and criticises that the stated preference information are hypothetical choices that might be overstated in survey response. This paper is more inclined to build the analysis on credibility and reliability of responses[11]. We believe that since treatments are randomly assigned across different households in customised pattern, it would ensure independence between the treatment status and the potential response outcomes, thereby allowing us to have causal interpretation of the treatment effect on valuation of DATES.

The scope of DATES differs from that of inputs-based, ICT-based or farmer field schools (FFS) agriculture experimental programmes (such as studied in Duflo, Kremer, and Robinson (2008); Beaman, Karlan, Thuysbaert and Udry (2013); Gershon Feder, Rinku Murgai, and Jaime B. Quizon (2004)) in three main ways: First, the intervention is synonymous to *'babysit'* field crops; it is a continuous one that lasts throughout the crop-cycle and involves multiple real-time treatments (based on customised requirement). Second, the mechanism used for disseminating the information ranges from in-person farm visits, facilitating demonstrations of new techniques to idiosyncratic interactions supported by IT/web-enabled tablet for real-time farm solutions. Third, it is close combination of traditional and modern tools of disseminating information to farmers. We thus

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to have 300 famers in control and treatment group in both project sites, with the hope that we will get sufficient number of farmers to attain satisfactory power for most of our focus crops (based on guidebook by Duflo et al. 2007)

[11] Dimond and Hausman (1994) explain that evaluation involves credibility, bias (also referred to as reliability in the literature), and precision of responses. Credibility refers to whether survey respondents are answering the question the interviewer is trying to ask. If respondents are answering the right question, reliability refers to the size and direction of the biases that may be present in the answers. Precision refers to the variability in responses. Precision can usually be increased by the simple expedient of increasing the sample size. Problems of credibility or of bias are not reduced by increases in sample size. Thus, credibility and bias must be evaluated when considering the use of such surveys.

report treatment effects from a policy of complete 'seed-to-seed' continuous treatment given to the farmers on placing value to it.

The key measure of interest is the impact of access to DATES on value of information, utilising the panel nature of the household data survey, comparing outcomes of the treatment (DATES) and control (non-DATES) before and after the programme. Value of information (DATES) is hypothesised to be affected by regressors which are invariant across panels, such as socio-demographic characteristics, a modified version of a "difference-in-differences" approach is employed (Ravallion, 2008).

A separate estimation exercise is taken-up for both project-sites: Gubbi and Siruguppa. Note that this paper is work in progress; hence, analysis using data only from Gubbi taluka is presented here. Analysis of Siruguppa will be taken up once the full data from Siruguppa arrives from the field.

EXPERIEMNTAL STATICSTICS AND EMPIRICAL STRATEGY

Descriptive Statistics and Baseline Balance in Gubbi

Table 3A and Table 3B compare control and treatment households in twelve gram panchayats (GPs), on a number of observable characteristics, as well as the key variable – value of information – which also manifests farmer's learning. Although, the control set of households in GPs (Hosakere, Kondli, Koppa, Nallur, Nittur and S. Kodaihali) are selected for their similarities with the treatment set of households in GPs (Bidare, C.S. Pura, Manchaldore, Mahavanhalli, M.H Patna and Paddanahalli), there are couple of notable differences worth pointing out between the aggregate means of control and treatment households. The mean level of cropping experience of farmers in treatment GPs is slightly higher than in the control GPs. The reverse is true for the mean level of education of farmers, which is higher in the control group than in the treatment group. The percentage of farmers facing income shock due to crop damage (mainly through drought) is higher in treatment group than in the control group. Similarly a higher difference in means can be seen for irrigated land in the control GPs as compared to the treatment GPs.

Table 4 presents tabulation of selected categorical variables and some key indicators varies. The visit of the extension service advisor (three times vs one time) from the local government is found greater in the treatment group than the controlled group. Although, caste plays a critical role in resource allocation in Indian society, it is noteworthy that the percentage of backward class (including Scheduled cast and tribes) households is higher in treatment GPs than in the control GPs.

Turning to the key outcome variable in table 3(B), we note that in the raw baseline data percentage of farmers in the treatment group, who are inclined to pay for the farm information, are higher in comparison to percentage of farmers in the control group. An intuitive reasoning could be inferred from table 3(A) which indicates that the treatment group faces income shocks due to crop damage and they are endowed with lower irrigation facility. Though difference between control and treatment group on these aspects is minimal, it might affect the treatment farmer's behaviour if he thinks information matters[12]. Post-treatment (post-2013) raw data shows substantial rise in the number of farmers in the treatment group, who are inclined to pay for the farm information. Some improvement is also witnessed in the control group. We believe that change in the control group occurs due to the effect of an expectation building. For instance, information about the project circulates through different channels – farmers visit markets and talk to each other and to commission agents, input shopkeepers, etc. Control farmers cannot benefit from the content of the information (i.e., customised project treatment) but build hope to receive it in future if they show their willingness to value it during the survey.

The control and treatment group are relatively good homogeneous group of farmers to test the research hypothesis. As per the research hypothesis, if experience of DATES enables farmers to learn, treated farmers group should witness increased number of farmers willing to pay for

[12] In the pilot survey (before the start of the experiment), we found that farmers were aware that they lack information, and there is considerable demand for high quality agricultural information.

information, and also overall improvement in the valuation of information among treatment farmers. A more detailed econometric analysis of the data to explore the impact of participating in the DATES treatment on valuing information is provided in the next section.

ANALYSIS

Empirical Strategy

As in Ravallion (2008), we estimate a double difference model (commonly known as difference-in-difference – DD) using a panel of households on value for farm information outcome. The DD approach allows us to estimate the differential valuation of information during the post-intervention period between treatment (participant) and control (non-participant) farmers relative to the outcomes observed during a pre-intervention baseline survey. We estimate the following regression model at the household level:

$$InfoValue_{igt} = \beta_0 + \beta_1 TargetDates_{it} + \beta_2 DatesParticipation_{it} + \beta_3 (TargetDates*DatesParticipation)_{it}$$
$$+ \sum \beta_4 Z_{it} + v_t + u_g + \varepsilon_{it}$$

Where $InfoValue_{it}$ is the logarithm of choice of value of information for household i in gram panchayat (GP) g at time t $TargetDates$ is an indicator variable equal to 1 for the households in six target GPs of Gubbi and 0 for households in six control GPs, $DatesParticipation$ is an indicator variable equal to 1 for households that denotes trial participation in 2014 and 0 for households for the year 2013, $TargetDates*DatesParticipation$ is the interaction of the preceding two terms, Z is a vector of household characteristics, and ε_{it} is an error term. The model accounts for time fixed effect v_t by including t -1 time dummy variable in the tested regressions. The motivation is that time common trends and annual specific shocks might affect the investigated relationships. Moreover, robust standard errors have been used in order to correct for the presence of any arbitrary heteroskedasticity of the residuals (White, 1980). All reported standard error in the results are clustered by GP. We also include a GP fixed effect, u_g, as the randomization was stratified along this dimension.

β_3 is the key parameter of interest. It shows how farmers' outlook changed in valuing agricultural information in comparison to other control farmers who were not provided with the DATES service. If DATES had the positive effect on farmers' learning and (possibly, but not necessarily, performance on the yield outcome), we should find a positive coefficient.

RESULTS

Effects on Value for Information

Table 5 presents the main regression results. Columns differ according to the variables progressively included in the specification: DATES impact without time fixed effect (column 1), DATES impact with both time and GP-wise fixed effects (column 2), other source of crop information (Column 3), public visits by Extension advisors (column 4), source of Income shock (column 5), owns mobile phone, owns motor bike and owns house (column 6), years of cropping experience, farmer's age in years, and farmer's education in years (column 7)[13]. GP and time fixed effects have been introduced as controls across all the specifications (2-7 columns). Based on prior farm studies, socio-economic characteristics of the farmer and the household, which notably could affect the use of DATES

[13] In the beginning, each of the variables was introduced in the model one-by-one and no change was witnessed in the results of the model.

services, were selected as control variables. Given the focus of this paper, we comment mainly on the effects of the DATES and not the other explanatory variables which are well documented in the literature.

We find that participating in the DATES intervention has a significant impact on farmers' subsequent valuing of the agricultural information. In column 7, the magnitude of coefficient on access to DATES indicates that a difference of each one unit (one cropping season) improvement in information access is found to be associated with 53% average increase in the mean valuation of the information as compared to the average valuation of households with no DATES, which is quite large. Other covariates are not found to be significant on aggregate terms in influencing value of information, with an exception of owning a house (a proxy of wealth). The DATES effects are consistent and robust throughout different specification, indicating that it plays a decisive role in valuing farm information and services, independent of other factors that are conceived to be important in explaining the differences in valuing information across households in treatment and control GPs.

Overall the results offer evidence that DATES participation led to positive improvement in valuing information on farm practices among treatment GPs relative to control GPs. It is strange not to find significant effect of other covariates that are expected to affect farmer's behaviour of valuing information. Thus, when interpreting the model, a preliminary conclusion can be drawn that there is some evidence to suggest that DATES intervention improves value of information significantly. The findings are quite noteworthy though, given that this impact is captured within a very short time horizon and extension services takes time to observe change on farm-level outcomes.

In the conceptual section we argued that if DATES is viewed by farmers under farm uncertainty as medium to increase their learning stock, we would observe differences in information valuation, irrespective of the fact that they could apply that information completely in the same season. Table 2 indicated that all farmers in the treatment might not have acted upon all of the 'seed-to-seed' advices received in Gubbi. The regression results confirm our intuition that farmers on average value real-time farm information significantly because they learn and appreciate the process of DATES. They might not (or might) act upon the learning in farm and it is less to do with their ability to learn new farm techniques. Also, existing literature notes value of information changes with social circumstances (WDR, 2015; Fafchamps and Minten, 2012). Intuitively, it is not implausible to argue that farmers, particularly with long cropping experience or elderly farmers would tend to identify themselves with farm traditions of their forefathers and take time to be flexible towards new farm technology provided in the DATES.

HETEROGENEOUS TREATMENT EFFECTS

While the role of information dissemination through information and communication technology (ICT) in improving rural welfare is highlighted, some fear that with ICT technological disparity will arise, and existing socio-economic inequality and poverty will be further exacerbated. There is a growing concern about the effect of digital divide in which the poor, illiterate or less experienced farmers are less able to grasp and take full advantage of technological progress to growth (Fernando and Cole, 2012; Warren, 2007; Warschauer, 2004). We expect that DATES may affect various strata of society or group diversely. We do not claim a prior if the effect of DATES is going to be positive or negative although we have combined both traditional and modern extension services to enrich the knowledge sharing experience, while catering the farm information needs in customised way.

We investigate empirically whether we can identify household categories that have been impacted by DATES more than others. We explore the hypothesis by comparing DATES intervention and valuing of information by education level, farmer's age, cropping experience, landholding and caste system of India.

Age, Cropping Experience and Education in years

Table 6 presents DD estimates when we split the sample according to the below- average and above average age-group of farmers in the sample. We find that average young farmers in the treatment

group significantly value information (Column 1). For a one-unit increase in access to information by younger farmers, we expect to see about a 73% increase in mean valuation for the information as compared to the average valuation by the young farmers with no DATES.
The significant impact of the DATES disappears for the older farmers. Thus, we do not find evidence that DATES was much appreciated by the farmers who are older in the treatment group.
In table 7, we explore by splitting the sample according to years of cropping experience among farmers. We find once again that farmers with less than average years of cropping experience significantly value farm information as compared to farmers who hold longer years of cropping experience. A difference of one unit improvement in access to DATES by less experienced farmers would lead to around 58% average increase in the mean valuation for the information relative to a less experienced farmer with no DATES.
In light of the debate on technological divide based on education, we also analysed in table 8 whether years of education affects the impact of DATES on valuing information. We find famers with no education seems to be benefitted most with DATES; we find large and significant difference in effect size by no education as compared with farmers of some years of education (Column 2 & 3) in the treatment group. We do not find evidence that those farmers with above the average years of educational attainment in the sample value DATES significantly, indicating a case of knowledge overlaps between highly educated farmer and DATES. The results are plausible as older generation or more experienced may be harder to get on board while younger people might be more receptive to the changes in farm practices caused by climate change concerns or advances in modern technology. This is useful finding in order to understand also the importance of mechanisms by which DATES works, which, as noted earlier, is a combination of traditional and modern ICT-based extension service[14]. As DATES is real time intervention, using audio and video, it serves both as educational tool to improve knowledge and advisory service to impart information about new technology. However, insignificant coefficient on the variables: more number of years of agricultural cropping experience or education does not indicate lack of comprehension to follow advice (appreciate advice). The results may be identified with 'nuanced view of human capital', proposed by Hanna et al, (2014).

Farmland Size

We investigate further whether we find evidence of heterogeneous effects by land ownership as presented in table 9. In our study, extension agents have experienced during their fieldwork that small farmers are found to be more receptive to the treatments within DATES intervention. It is because (according to the staff experience) local fertilizer shops give preferential advice to big farmers than the small ones. Therefore, extension agents in the project sometimes had to make more number of visits to convince big farmers to adopt farm advice (such as not to over-use chemicals/ and mix of two chemicals incorrectly). Empirical studies provide evidence specifically from a range of developing countries, including India, showing that farmers with smaller land-holdings are more efficient in making use of new farm technology (information) (Berry and Cline, 1979; Tadesse and Krishnamoorthy, 1997). More recent literature also identifies the inverse relationship between farm size and land productivity under the current land management system. For instance, Ansoms et al., (2008) analyse data from Rwanda finds that small production units perform better per land unit than larger one. The study finds that the risk-coping mechanisms of small-scale farmers, such as farm fragmentation, and multicropping pay off in terms of productivity.

[14] We also estimated the model using interaction terms separately (results available on request). We learnt that value of information is increasing in the lesser level of cropping experience or education amongst farmers, and more experience/education levels per se do not affect the magnitude of information intervention effects. Overall, results suggest that DATES like intervention, which makes use of ICT-based video and audio to familiarise information, can improve access to information to less educated people and enhance capabilities to make strategic choices and improve their income. The results can be identified with Harris and Rajora (2006) that also shows beneficial impact of ICT on rural welfare.

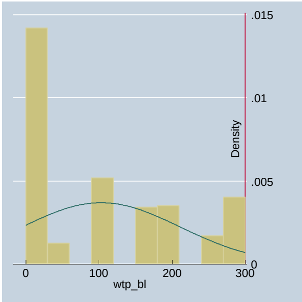
Using the farm-level panel data from Hubei province in China from 1999 to 2003, Li et al., (2013) confirms the similar causal inverse relationship between land productivity and farm size in China. Nonetheless, it remains to be verified in our experiment of evaluating impact on productivity.
As regards valuation results of DATES, we find large and significant evidence of heterogeneous effects for the households with less than average size of landholdings. The result shows that for a one unit improvement in information access to small landholders, we expect to see about an 83% average increase in the mean valuation for the information relative to a small landholder with no DATES

Caste
Impact of DATES on farmers may vary with respect to their caste. We therefore also examine whether value of information (DATES) differs in context of the cast system in India. While the influence of caste on economic transactions might be declining due to the spread of better functioning markets, there is little doubt that caste still plays an important role in shaping both economic and social transactions in rural India (Anderson, 2011). Consistent with the recent literature, we find that scheduled caste (SC) households significantly place more value to real-time information provided through DATES intervention. The coefficient is one of the largest amongst the various model specifications in the paper and is significant at $p<0.1$; a difference of one unit improvement in access to DATES by SC farmers is found to be associated with more than 200% average increase in the mean valuation for information as compared to the average valuation of lower caste people with no DATES (see Table 10). This result may not be surprising despite that the Indian State recognises the regressive role of caste, and has progressively worked to design policies that reduce the disadvantage faced by lower castes. A recent study finds that farmers' access to formal agricultural credit (loans) is influenced by their caste (Kumar 2013), specifically in terms of source of agricultural production loans. Evidence indicates that an SC farmer is somewhat more likely to receive an agricultural loan than his OBC or higher caste counterpart from the commercial banks than from rural cooperative banks. In rural settings of India, discrimination against SC farmers is still a major societal concern. SC farmer would normally be the one more likely to prefer an independent source (may be a private market) for farm information when public-based farm information is prone to be captured by interest group from higher caste.
From policy point of view, the results indicate that DATES as technology-based independent information service, all else being equal, is likely to reduce existing caste-based inequality and reduce poverty.

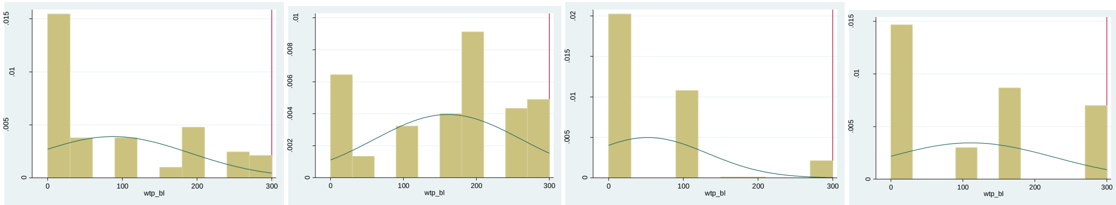
ROBUSTNESS CHECK

Following the basic model estimation, we conduct robustness analysis to check the validity of our identification strategy. Similar to Corrigan and Rousu (2006); Oparinde et al. (2014), we estimate random effect Tobit model that take into account both the panel nature of our data and the possible influence of censoring in preferences for valuing farm information (dependent variable). In Gubbi, on an average from pooled treatment and control sample, about 42.6 percent stated zero value, around 19 percent stated price choice less than or equal to 100, and 12 percent equal to 300 as the highest price.
Looking at the histogram in figure 1 that shows the distribution of Value of Information, we can see the censoring in the data, that is, there are far more cases with scores of 0, 300 than one would expect looking at the rest of the distribution. Thus, it makes a case to reconfirm the findings through use of Tobit model.

Figure1: Distribution of Value of Information



Aggregate 2013-2014



Treatment 2013 Treatment 2014 Control 2013 Control 2014

We consider left censored model (equal to or less than 100), where price choices are assumed to be censored from below at a lower limit of the price distribution used in the experiment. Together with it, we consider right censored price value, where price choice is assumed to be censored from above at the upper limit of price distribution used in the experiment (equal to 300). It is possible to assume that that those farmers who submitted price equal to the minimum obtainable because of the intangible property of the information. Not just farmer is unknown about the usefulness of information service but also the choice might be influenced by their past experience of poor information received (or received none) from the local government/sources. With regard to farmers who stated maximum price choice, it could be due to perceived transaction cost of obtaining the information and learning about modern agricultural practices. Also, the choice might be influenced by comparing DATES with alternative source of information outside the experiment.

The results, presented in table 11, once again confirm that participating in the DATES intervention has a significant impact on farmers' subsequent valuing of the agricultural information. The magnitude of the coefficient on access to DATES is even bigger than the OLS estimation and it indicates that for a one-unit increase in access to information, we expect to see more than a 300% average increase in the mean valuation of the DATES as compared to the average valuation by the farmers with no DATES. The coefficient is significant at $p<0.1$.

CONCLUDING REMARKS

This paper presents the results from a randomised controlled trial (RCT) of the impact of providing Dynamic Agricultural Tablet based Extension Service (DATES) in Gubbi taluka of Karnataka on valuing information. We explore a specific hypothesis in the paper – we ask if better valuation of information by economic agents (farmers) is thought to make up a large share of the learning return, which many a time might not reflect immediately in farm outcome, such as yields or pattern of use of information captured in agricultural practices –, which to our knowledge is not explored earlier using the RCT experiment in the context of providing to farmers real time farm information from agronomists, trained agricultural extension agents.

The paper makes a point that because information is not useful in one year does not imply that it is never useful. Agricultural farmers face many different types of uncertainty and role of flow of locally relevant information should not be undermined. The study employs the difference-in-difference model to a panel of households comparing the differential valuation of information during the post-intervention period between treatment (participant) and control (non-participant) farmers relative to the outcomes observed during a pre-intervention baseline survey. We find robust evidence of the intervention showing significantly positive impacts on the valuation of agricultural information among treatment farmers relative to the control farmers. A difference of each one unit improvement in information access is found to be associated with 53% average increase in the mean valuation for the information and thus identifying DATES as an educational tool to improve knowledge and advisory service to impart new technology. These results are encouraging considering that they capture direct and relatively short-term effects of farm extension services (DATES) on farmer's behaviour in valuing information. One could expect that changing farming practices is a long process, which would possibly reflect its effects after a long time only on yields or use of farm inputs. The study demonstrates effects of DATES on farmer's valuing of the farm information, without resorting to yield analysis, that otherwise are hard to measure.

We also find evidence that less educated and marginal farmers have higher value for agricultural information as compared to the wealthier or educated farmers, reflecting the growing disparity in accessing agricultural information in developing countries. These findings shed light to also understand that formal education is not the key barrier to grasp information; but possibly both the channel and design of information flow to farmers are more relevant for information to benefit famers.

This study also contributes to the behavioural economics literature (WDR, 2015), which suggests that the choice of farm household to invest in DATES and adopt new agricultural technology may be influenced by the expected costs and returns but it is equally important that farmers need adequate cognitive space and time to make the best decisions for themselves. Many a times, unobservable factors such as the pattern of learning support, farmer's preferences and also constraints stemming from farmer's own social identity playing a key role in influencing farmer's behaviour regarding decision-making.

Further research is under progress to identify impact of DATES on yields. If DATES proves to close yield gaps and improve welfare of farmers, a successful transition from a controlled trial setting to a scaled-up, applied setting will crucially hinge on devising effective information dissemination mechanism and pricing schemes that take into considerations household characteristics, expectations, preferences and constraint into account, than a generic extension service model. This study helps to form understanding that information that is comprehensive, real-time and contextual as opposed to the more generic or piecemeal information provided in some recent experimental studies is more powerful to influence farmers to build trust and shun skepticism towards provision of knowledge and information, offering cognitive space and motivation to farmers in taking appropriate farming risks.

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Table3A: Control and Treatment Households – Baseline Balance Check

Socio-Economic Characteristics- Summary Statistics

	Cntr	Trt	Cntr	Trt	Cntr	Trt	Cntr	Trt	
Variable	**2013 Obs**	**2013 Obs**	**2013 Mean (Std. Dev)**	**2013 Mean (Std. Dev)**	**2013 Min**	**2013 Min**	**2013 Max**	**2013 Max**	**2013 P-value***
Size of the Farmer's Family	300	300	5.15 (2.39)	5.09 (2.46)	1	1	19	21	0.76
Farmer's age in years	300	300	50.65 (13.63)	50.55 (12.73)	23	25	86	80	0.93
Farmer's education in years	300	300	6.69 (4.71)	5.91 (4.77)	0	0	18	17	.045
Farmer's cropping experience in years	300	300	29.82 (12.20)	31.67 (12.59)	2	5	55	67	0.067
Farmland owned by the Farmer in Kharif (in acres)	300	300	4.06 (3.94)	4.68 (4.36)	0.325	0.5	30	45	0.069
Farmland cultivated by the farmer in Kharif (in acres)	300	300	4.00 (3.32)	4.55 (4.35)	0	0	23	45	0.083
Farmland irrigated by the farmer in Kharif (in acres)	300	300	1.78 (2.81)	1.63 (2.53)	0	0	16.5	20	0.48
Number of visit of the Public Extension Advisor	300	300	1.036 (.44)	1.18 (.55)	0	0	3	3	0.0005
Own House	300	300	.416 (.493)	.55 (.498)	0	0	1	1	0.0011
Own Mobile phone	300	300	1.15 (.759)	1.116 (.66)	0	0	5	5	0.566
Own Motor bike	300	300	.52 (.608)	.593 (.645)	0	0	3	5	0.1527
Whether experience income shock in kharif?	300	300	.893 (.309)	.94 (.237)	0	0	0	1	0.0387

* **H0: mean(T) - mean(C) = 0 *i.e.* C = T**

Table 3B: Summary Statistics: Dependent Variable
Pre and Post-Intervention Valuing of Information *(Raw Values)*

	Treatment	Control	Difference
Pre-Intervention Valuing Information 2013 (% of farmers)	53.65 %	39.32%	14.33%
Post-Intervention Valuing Information 2014 (% of farmers)	80.67 %	56%	24.67%
Difference (Increase in Worth)	27.02%	16.68%	**10.34%**
Pre-Intervention Free Info 2013 (% of farmers)	46.33%	60.67	14.34%
Post-Intervention Free Information 2014 (% of farmers)	19.33%	44%	24.67%
Difference (Reduction in Zero Worth)	27%	16.67%	**10.33%**

Authors' calculations

Table 4: Tabulation of the categorical variables, Baseline 2013

Control **RSK Satisfaction**	**Frequency**	**Percentage**	**Cumulative**
0=Satisfied	32	10.96	10.96
1=Not Satisfied	71	24.32	35.27
2=Not Interested	189	64.73	100.00
Source of Crop Information			
0 No information Source	203	67.67	67.67
1 Public Source= RSK + KVK+ Marketing board SMS service+ Kissan Call Center	45	15.00	82.67
2 Private Source = NGO+ Veterinary hospital+ Agri college+ Co-operative society+ Other + Media (i.e. Radio/ T.V./ Newspaper) + Farm magazines like Annadata, Krishimunnade, Krishimitra or Sirisamrudhhi+ Self	9	3	85.67
3 Informal= Farmers within and outside village + Input dealer or traders	43	14.33	100.00
Reason for RSK Visit (Rayata Samparka Kendra: Government office to provide agricultural facilities)			

Treatment **RSK Satisfaction**	**Frequency**	**Percentage**	**Cumulative**
0=Satisfied	59	19.73	19.73
1=Not Satisfied	91	30.43	50.17
2=Not Interested	149	49.83	100.00
Source of Crop Information			
0 No information Source	233	77.67	77.67
1 Public Source= RSK + KVK+ Marketing board SMS service+ Kissan Call Center	62	20.67	98.33
2 Private Source = NGO+ Veterinary hospital+ Agri college+ Co-operative society+ Other + Media (i.e. Radio/ T.V./ Newspaper) + Farm magazines like Annadata, Krishimunnade, Krishimitra or Sirisamrudhhi+ Self	2	0.67	99.00
3 Informal= Farmers within and outside village + Input dealer or traders	3	1.00	100.00
Reason for RSK Visit (Rayata Samparka Kendra: Government office to provide agricultural facilities)			

0=	165	55.37	55.37
1 = collect seed & fertilizer	118	39.60	94.97
2 = collect information	14	4.70	99.66
3 = other			
4 = soil test			
5 = to collect seeds, but did not get/receive anything			
6 = to collect plants			
7 = information of plantation in horticulture dept			
8 = machinery information	1	0.34	100.00
9 = insecticide information			
Caste			
1 = General;	211	70.33	70.33
2 = Scheduled caste;	25	8.33	78.67
3 = Scheduled tribe	26	8.67	87.33
4 = Other backward caste	34	12.67	100.00
Source of shortfall of income			
0= No Shortfall	23	7.67	7.67
1=Crop failure due to drought/Flood + Crop damage due to other reasons	274	91.33	99.00
2=Health Problems of family member + Other	3	1.00	100.00
Coping strategy for income shortfall			
0=	33	11.00	11.00
1=Sale of Land	1	0.33	11.33
2=sale of livestock	69	23.00	34.33
3=sale of other assets			

0=	135	45.00	45.00
1 = collect seed & fertilizer	151	50.33	95.33
2 = collect information	9	3.00	98.33
3 = other	1	0.33	98.67
4 = soil test			
5 = to collect seeds, but did not get/receive anything	2	0.67	99.33
6 = to collect plants	1	0.33	99.67
7 = information of plantation in horticulture dept	1	0.33	100.00
8 = machinery information			
9 = insecticide information			
Caste			
1 = General;	163	54.33	54.33
2 = Scheduled caste;	45	15.00	69.33
3 = Scheduled tribe	28	9.33	78.67
4 = Other backward caste	64	21.33	100.00
Source of shortfall of income			
0= No Shortfall	17	5.67	5.69
1=Crop failure due to drought/Flood + Crop damage due to other reasons	283	94.33	100.00
2=Health Problems of family member + Other			
Coping strategy for income shortfall			
0=	21	7.00	7.00
1=Sale of Land	1	0.33	0.33
2=sale of livestock	112	37.33	44.67
3=sale of other assets			

& commodities			
4=Found a job inside the village	64	21.33	55.67
5=Migrated in search of job	5	1.67	57.33
6=Borrowing	115	38.33	95.67
7=other	13	4.33	100.00
Visit by Extension service advisor			
0= No visit	16	5.33	5.33
1= one visit in a month	265	88.33	93.67
2= two visit in a month	11	3.67	97.33
3= three visit in a month	8	2.67	100.00
Possess motor bike			
0=No	158	52.67	52.67
1=Yes	142	47.33	100.00
Possess mobile phone			
0=No	34	11.33	11.33
1=Yes	266	88.67	100.00
Possess House			
0=No	175	58.33	58.33
1=Yes	125	41.67	41.67

& commodities			
4=Found a job inside the village	94	31.33	76.00
5=Migrated in search of job	2	0.67	76.67
6=Borrowing	57	19.00	95.67
7=other	13	4.33	100.00
Visit by Extension service advisor			
0= No visit	1	0.67	0.67
1= one visit in a month	264	88.00	88.67
2= two visit in a month	12	4.00	92.97
3= three visit in a month	22	7.33	100.00
Possess motor bike			
0=No	141	47.00	47.00
1=Yes	159	53.00	100.00
Possess mobile Phone			
0=No	25	8.33	8.33
1=Yes	275	91.67	100.00
Possess House			
0=No	135	45.00	45.00
1=Yes	165	55.00	100.00

Table 5: Impact of Dynamic Agricultural Tablet-based Extension Service (DATES) on Valuing Information (DiD Estimates)

	(1) Ln(Value Info)	(2) Ln(Value Info)	(3) Ln(Value Info)	(4) Ln(Value Info)	(5) Ln(Value Info)	(6) Ln(Value Info)	(7) Ln(Value Info)
Target Dates	0.243	0.096	0.150	0.139	0.119	0.253	0.277
	[0.178]	[0.570]	[0.571]	[0.576]	[0.578]	[0.578]	[0.583]
DATES Impact	**1.564*** **	**0.534** **	**0.534** **	**0.534** **	**0.534** **	**0.534** **	**0.534** **
(Target Dates*Year '14)	[0.189]	[0.261]	[0.261]	[0.261]	[0.262]	[0.262]	[0.262]
Constant	2.403***	1.464**	1.424**	1.217*	1.123	0.875	0.919
	[0.104]	[0.603]	[0.607]	[0.725]	[0.752]	[0.791]	[1.395]
Other Controls	No	No	Yes	Yes	Yes	Yes	Yes
GP Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed Effects	No	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.088	0.217	0.219	0.219	0.219	0.222	0.223
F	69.092	37.906	31.441	26.815	24.343	21.565	19.328
N	1200	1200	1200	1200	1200	1200	1200

Note: *Robust Standard errors in brackets * p < 0.1, ** p < 0.05, *** p < 0.01; Control variables progressively included in the Estimation- Source of Crop Information (Public source, Private source or other farmer; column 3), Number of visits by Public Extension Advisor (one, two or three visits a month; column 4), Source of Income Shock (crop damage, ill-health; column 5), Mobile phone factor, motorbike factor, owning house factor; column 6), Ln(Years of cropping experience), Ln(years in age), and Ln(years of education; column 7 –full model) GP Fixed Effects & Time Fixed Effects (2-7 columns)*

Heterogeneous Effect of Treatment

Table 6: Impact of DATES on Valuing Information based on Farmer's Age (DiD Estimates)

	(1) Ln(Value Info) age<=46	**(2) Ln(Value Info) age>47**
Target Dates	-1.140	1.066
	[0.950]	[0.657]
DATES Impact	**0.734***	**0.382**
(Target Dates*Year '14)	[0.402]	[0.345]
Constant	2.831**	-0.216
	[1.182]	[1.001]
GP Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
R^2	0.239	0.239
F	6.382	14.217
N	512	679

Note: *Robust Standard errors in brackets * p < 0.1, ** p < 0.05, *** p < 0.01; Estimates include controls- Source of Crop Information (Public source, Private source or other farmer), Number of visits by Public Extension Advisor (one, two or three visits a month), Source of Income Shock (crop damage, ill-health), mobile phone factor, motorbike factor, owning house factor), GP Fixed Effects, Time Fixed Effects*

Table 7: Impact of DATES on Valuing Information based on Farmer's years of Cropping Experience, (DiD Estimates)

	(1) **Ln(Value Info)** exp_c<=35	(2) **Ln(Value Info)** exp_c>35
Target Dates	-0.481	0.988
	[0.818]	[0.893]
DATES Impact	**0.577***	**0.464**
(Target Dates*Year '14)	[0.331]	[0.430]
Constant	1.535	-0.216
	[0.986]	[1.495]
GP Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
R^2	0.244	0.213
F	9.720	4.636
N	746	454

Note: *Robust Standard errors in brackets * p < 0.1, ** p < 0.05, *** p < 0.01;*

Table 8: Impact of DATES on Valuing Information based on Farmer's years of Education, (DiD Estimates)

	(1) **Ln(Value Info)** Edu=0	(2) **Ln(Value Info)** Edu<=7	(3) **Ln(Value Info)** Edu>7
Target Dates	2.051**	-0.558	0.226
	[0.965]	[0.958]	[0.945]
DATES Impact	**1.224****	**0.797***	0.024
	[0.533]	[0.468]	[0.393]
Constant	-2.272*	1.527	1.553
	[1.350]	[1.605]	[1.194]
GP Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
R^2	0.302	0.262	0.247
F	16.816	9.724	12.768
N	290	380	530

Note: *Robust Standard errors in brackets * p < 0.1, ** p < 0.05, *** p < 0.01; In both table 7 & table 8, Estimates include controls- Source of Crop Information (Public source, Private source or other farmer), Number of visits by Public Extension Advisor (one, two or three visits a month), Source of Income Shock (crop damage, ill-health), mobile phone factor, motorbike factor, owning house factor), GP Fixed Effects, Time Fixed Effects*

Table 9: Impact of DATES on Valuing Information based on Farmer's Land Size, (DiD Estimates)

	(1) **Ln(Value Info)** la_ow_k<=4	(2) **Ln(Value Info)** la_ow_k>=4
Target Dates	-0.128	1.034
	[0.615]	[1.759]
DATES Impact	**0.828*** **	**0.406**
(Target Dates*Year '14)	[0.318]	[0.422]
Constant	1.547*	0.696
	[0.920]	[1.962]
GP Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
R^2	0.218	0.226
F	14.498	8.185
N	808	494

Note: *Robust Standard errors in brackets * p < 0.1, ** p < 0.05, *** p < 0.01;*

Table 10: Impact of DATES on Valuing Information based on Farmer's Caste, (DiD Estimates)

	(1) **Ln(Value Info)** Caste= General	(2) **Ln(Value Info)** Caste= SCST
Target Dates	0.531	2.114**
	[0.653]	[0.842]
DATES Impact	**0.120**	**2.121*** **
(Target Dates*Year '14)	[0.338]	[0.732]
Constant	-0.455	0.355
	[0.980]	[1.954]
GP Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
R^2	0.211	0.443
F	11.742	51.199
N	748	140

Note: *Robust Standard errors in brackets * p < 0.1, ** p < 0.05, *** p < 0.01;*

Robustness Check: TOBIT Model

Table 11: Impact of DATES on Valuing Information (DiD Estimates)

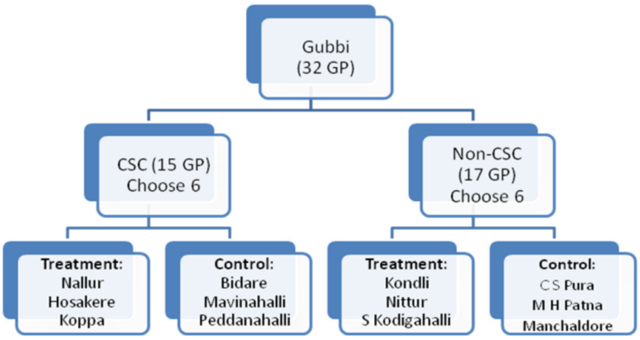
	(1) **Ln(Value Info)**
Target Dates (d)	-0.6588
	[0.5522]
DATES Impact (d)	**3.3915*** **
	[1.1295]
GP Fixed Effects	Yes
N	1200
pseudo R^2	0.098

Marginal effects; Standard errors in brackets (d) for discrete change of dummy variable from 0 to 1
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

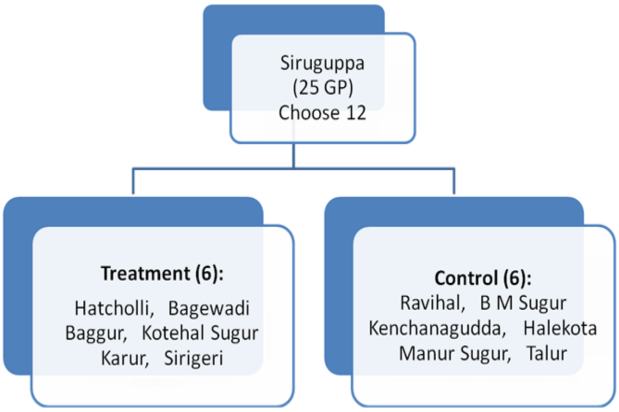
Note: *All estimates in table 9, 10, & 11 include controls- Source of Crop Information (Public source, Private source or other farmer), Number of visits by Public Extension Advisor (one, two or three visits a month), Source of Income Shock (crop damage, ill-health), mobile phone factor, motorbike factor, owning house factor), GP Fixed Effects, Time Fixed Effects*

Appendix A (i)

Overview of Selection of GPs in GUBBI

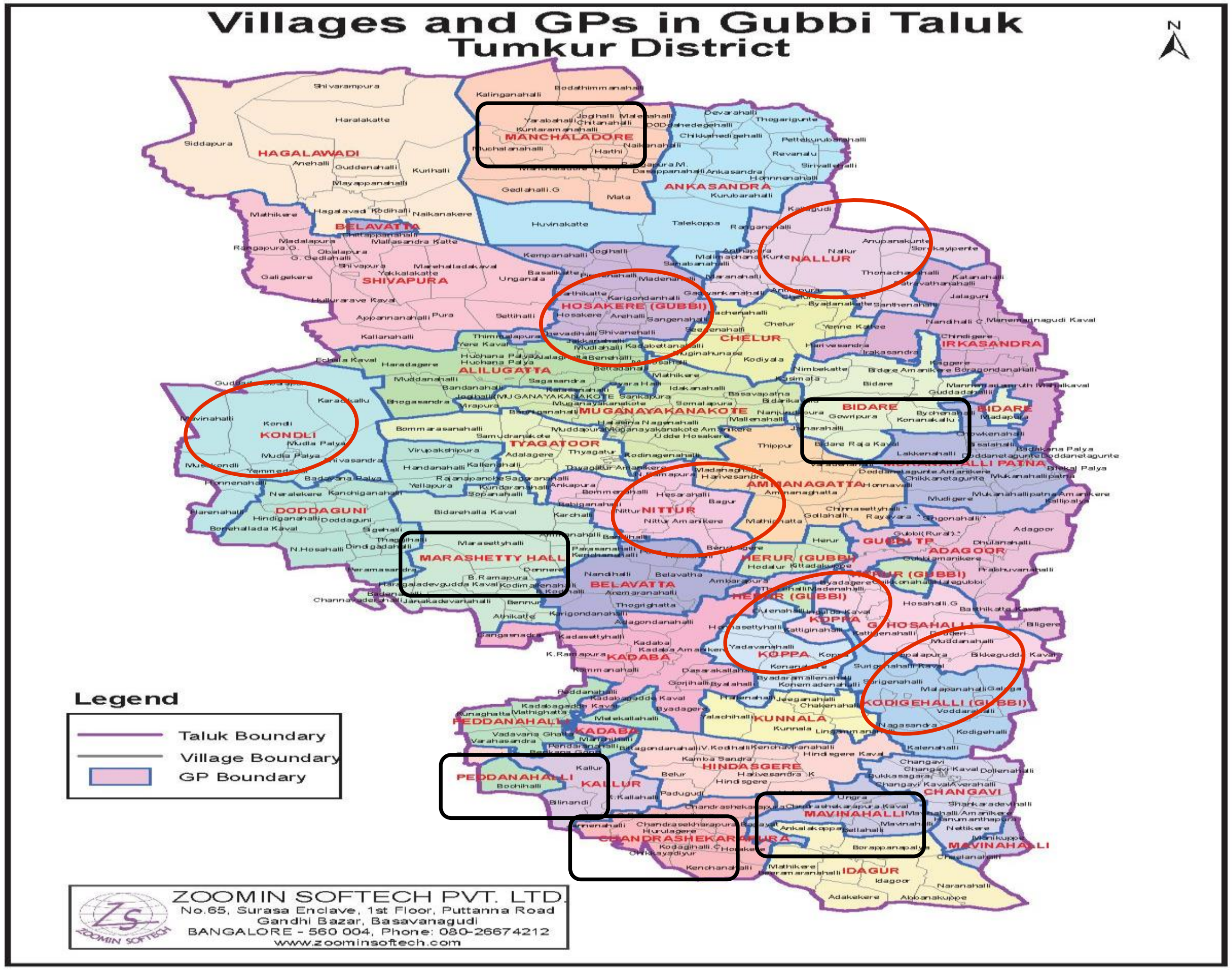


Overview of Selection of GPs in SIRIGUPPA



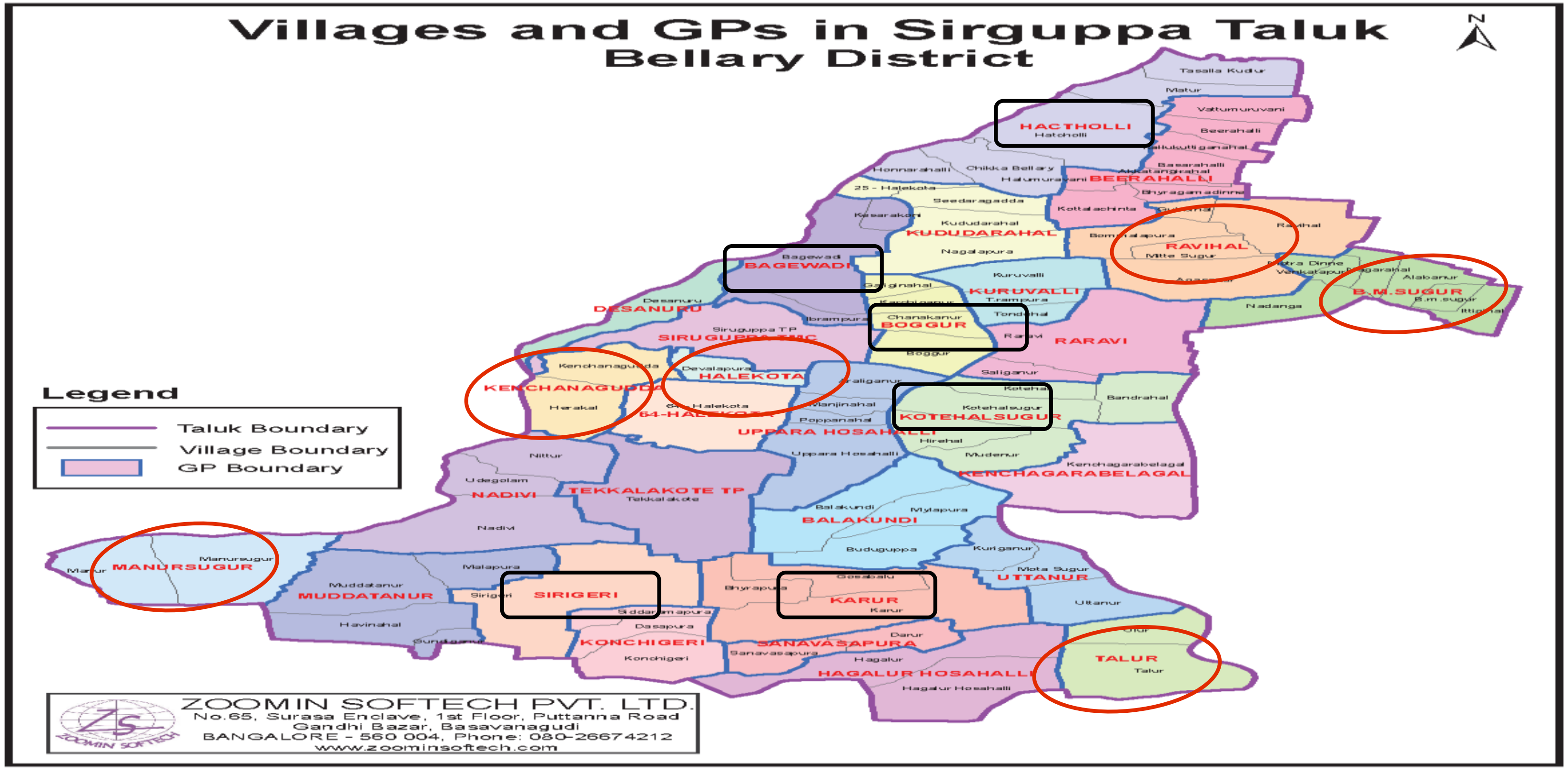
Appendix A(ii): Geography of the Study sites though Map

Appendix A(iii) GUBBI*



Control GPs (Oval): Hosakere, Kondli, Koppa, Nallur, Nittur and S. Kodaihali
Treatment GPs (Square): Bidare, C.S. Pura, Manchaldore, Mahavanhalli, M.H Patna and Paddanahalli
***** No treatment and control GPs are next to each other

Appendix A(iv) SIRIGUPPA*



Control GPs (Oval): BM Sugur, Kenchanagudda, Halekote, Ravihal, M Sugur, Talur
Treatment GPs (Square): Bagguru, K Suguru, Bagewadi, Hatcholli, Sirigeri, Karur
* No treatment and control GPs are next to each other

Appendix B(i): Note on salient observations and concerns in the process of design of the experiment and collection of price bundles

In February-March 2013, we conducted a small scale pilot survey in both the project sites to collect information on existing level of farm productivity, sources of agriculture related information to farmers, their demand for more specific information and willingness to pay for such service, functioning of the agricultural offices set up by the Government of Karnataka and Government of India, and activities of NGOs.

Two data collection methods were employed in Gubbi at the pilot survey phase. Gubbi has Common Service Centres (CSC), an informal establishment at the GP level where farmers can visit to obtain farm related information. CSC was local government initiative but got defunct over the time. IIM, Bangalore (co-investigator) revived CSC working in Gubbi informally through its own funds. We used CSC to meet farmers to collect pilot information in Gubbi. CSC operator took the interview whenever a farmer visited him/her and agreed to take survey. The other way was to talk to farmers by visiting them directly. In Siruguppa, a farmers' meeting was organized by the Head of the Agricultural Research Station, run by the University of Agricultural Sciences, Raichur. Farmers were interviewed through an interpreter following a short questionnaire. In the process, we had collected information from 44 farmers in Gubbi and 28 farmers in Siruguppa. Some salient observations from pilot survey are as follows.

First, about 90% of surveyed farmers do not get good quality information about agricultural practices and markets from government offices such as Rayata Samparka Kendra (RSK) and Krishi Vignana Kendra (KVK). Majority of the respondents did not obtain any training on modern agricultural practices and they do not have any idea where to get such information. Whereas, the officers at those centres would say that they advertise in local newspaper and conduct training for 'those who are interested'. Second, for many farmers their crop yield is lower compared to what could be obtained in field experiments. Third, majority of the interviewed farmers were willing to pay if a reliable source could provide agriculture related information to them. Based on pilot survey and personal communication with NGO officers, price bundles were identified.

Non-Government Organisations (NGO) have strong presence in Gubbi. From the pilot survey, we came to know that two of them – Initiatives for Development Foundation (IDF) and Shri Kshetra Dharmasthala Rural Development Project (SKDRDP) had close ties with farmers. To know more about their operations, visits were made to their offices and farmer meetings conducted by them.

The IDF requires minimum 10 persons (from different families) to form a Self Help Group (SHG) or Joint Liability Group (JLG). Minimum 4 or 5 SHG/JLG are required to form a CUTA (at GP level) and one IDF field officer is appointed to work with that CUTA. The field officer conducts classes/meetings every Tuesday. First and third Tuesdays are devoted to agricultural issues and the second one is devoted to financial issues. The fourth Tuesday is devoted to implementation. The IDF brings specialists to the GP/CUTA to give demonstrations or to give lecture on more specific topics. They print a book totally devoted to agriculture (in Kannada, with black & white pictures) and sell it to the farmers at INR 100. They also circulate a very innovative calendar which has a lot of agricultural information relevant to the local farmer. They give these at free of cost to CUTAs. If any farmer wants to buy for personal copy, it is available at INR 50.

The SKDRDP also helps farmers in various ways[15]. The fundamental objective of SKDRDP is promotion of intensive mixed farming in the area using cost effective technology to increase income levels. In recent past, the NABARD sanctioned funding under its Umbrella Programme in Natural Resource Management (UPNRM) to the SKDRDP to assist paddy cultivators in Karnataka. The beneficiary farmers were happy that per acre yield increased in the range of 25-45%. The organization is regularly conducting annual *Kissan Melas* (farmer's fair) and organizing training, field visit, installation of demonstration plots etc. for capacity building of farmers registered with them.

[15] http://www.skdrdpindia.org/ ; http://www.skdrdpindia.org/pdf%20files/Annual%20Report%202011-12.pdf

So, we needed to be cautious in order to protect the experiment from any potential spill-over effect from their activities. It was impossible to know at the time of sample selection, whether the chosen farmer is a beneficiary of any NGO or not. However, the baseline survey questionnaire contained explicit questions on farmer affiliation to any NGO, and his sources of agricultural information. We use the information as control variables in the empirical analysis.

Appendix B(ii): Value for Information (DATES): Post-intervention Telephonic Conversation Script translated from Kannad to English. The script was modified accordingly to suit treatment farmer, control farmer and the spillover farmer.

Namaskara (Greetings).

We are calling from IIM – Bangalore. Are we talking to Mr. Giridhar S/o Hemchand Pradhan of Kilinochi village? Good. We hope that our field staff visits you every month to provide you crop specific information (or diary writing). Isn't it? We are a part of the same team from IIM-Bangalore. Are you free now? Can we talk to you for a few minutes? Ok. Thank you.

Could you please tell us, which crop you are cultivating right now? Ok.

We are conducting a survey on providing agricultural information for the crop you are cultivating. Ok. Let us ask you this question.

The question is "Suppose if a reputed organization offers you DATES services (i.e. crop and animal specific agricultural information on pest control, fertilizer application, plant protection, animal husbandry, loan schemes, crop insurance, current prices of nearby markets) – Will it be useful for you ?".

"Suppose if an extension or agricultural agent visits you bi-weekly for providing all the requisite information for the crop you are cultivating - Are you willing to pay a season-wise subscription fee (on per acre land basis) ?"

If yes, are you willing to pay Rs. ____________ per acre per season? Is that OK for you?

If not then, are you willing to pay Rs. _____________per acre per season? Is that OK for you?

If not then, are you willing to pay Rs. ___________ per acre per season?

Thank you for your valuable time.