Based on the project

"Information, Market Creation and Agricultural Growth"

We thankfully acknowledge the support of ESRC-DFID funded research project with ESRC Grant Reference: ES/J009334/1. The views expressed in this paper are entirely those of the author and in no way represent either the official policy of funders or the policy of any other part of the UK government.

The project is implemented in partnership with Institute of Social and Economic Change, Bangalore and University of Agricultural Sciences, Bangalore.

Research jointly supported by the ESRC and DFID

This document outlines a methodology for assessing the impact of varying survey frequencies on key outcomes among households in control and treatment villages. The analysis will be based on data generated from a randomized controlled trial (RCT) detailed in this document.

Introduction:

Starting with Adam Smith, economists have arrived at a consensus that information availability (access) is both a costly and valuable component of efficient markets; "knowledge is power" (Stigler, 1961:213). To overcome the perceived information failures in the agricultural sector, many governments have long been producing and distributing information on appropriate agricultural practices to the farming community for technology adoption and to impact agricultural productivity. Such publicly provided information is an ongoing effort of governments in developing countries to assist farmers in becoming 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 publicly 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 the emphasis on alternative efforts in information supply is mainly due to the weak adoption of improved practices in developing countries, which is well documented (see Aker, 2011; Dinar, 1996). There is an increasing number of theoretical and empirical literature that explains the determinants of the adoption of agricultural technology in different contexts. 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 analyse the value of a single or generic set of information to farmers, when each of whom might have different information needs 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 the 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 the value of information is focused on production. The mixed evidence of the efficacy of farm information makes it difficult to ascertain whether it is due to differences in information models or methodological challenges associated with evaluating information programmes without a plausible exogenous variation mechanism (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 agent, the roles of different types of information and individual's attitude and aptitude towards learning and application of information.

In this paper, we assume that the display of low yields or unscientific practices after the information bundle is provided are not outcomes of subjective bias attributed to prior poor agricultural practices or learning failure. This is not an improbable assumption, given that farmers face many different types of uncertainty. Yields may fluctuate due to unfavourable weather, pest and disease problems, and 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

[1] In the context of structural and organisational change in agriculture, the 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, pp: 173; Anderson and Feder, 2007; Just et al., 2002: 39).

information that need not necessarily always result in higher yields. Hence, examining yield outcomes to evaluate farmers' learning, as done by some recent studies, may not always be appropriate. 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 we took from our field visit and discussion with paddy farmers in the South of India:

> *'Though many varieties of rice exist, 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 of seeds supported high yields and was also equipped with an adaptation measure to deal with limiting water resources. Nonetheless, farmer's expectation to reap high yields depends on many features of the 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 days old, as the yield declines of older seedlings, chose to transplant more than 55-day-old seedlings. This farmer made a choice between losing the entire investment of the season or reconciling with sub-optimal rice yield. The argument of 'to do it right' 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 then 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, the farmers had learnt to lay the foundation for determining plant growth and yield but could not practice it. (Based on authors' experience in the field experiment, August 2012)*

Table 1 presents more of such selected field-based observations that were found more 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 a tailored way through treatment intervention. The two tables distinguish in terms of the importance of the information packaging both to impart the right knowledge and to manage shocks in real-time, while both have an 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 has 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 Artificial Intelligence (AI)-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 part of a 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, leads 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, farmers 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 this, yield outcomes might not always reveal the significance of learning from extension services.

Studies also suggest that there is a temporal dimension of extension services (Maffioli et al. 2011). 'How valuable information depends on the context: because the 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	Project's field staffs suggested to spray 2

		flowering season. As a consequence of it, most of the cotton squares dropped from the plants.	kg of DAP, 1 kg all 19 (19:19:19) along with 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 the problem (binding constrain) under credit purchases
6.	Similarly, yield differences exist between irrigated and rain-fed cotton fields	The non-availability of water in the major critical stages of cotton crops, viz., germination, flowering, and boll formation, affects yield optimization.	Consistent Problem

Source: Field Experiment, 2013-2014

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

Table 2: Widespread incorrect farm practices

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	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.

	Based on soil test report, undertaken in the project, 75% of soil in the study area is deficient in 'P' content.		
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 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.	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 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, 2012-2013

In our randomized field experiment, farmers' valuing of information might reflect the gain in new farm learning and acceptability of additional information services. However, the literature suggests that valuing information (willingness to pay) for farm information services has slowly emerged in many settings (Anderson and Feder, 2007, 2004). This could also be true in the 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 derived from it was never considered as a means to generate resources for the service provider. Moreover, the extension was considered some sort of public education, and making it 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). We foresee other subjective behavioural choice challenges affecting the evaluation of information. Even if the model delivers information in real-time, significantly improves development outcomes such as low costs, higher yield, and greener ways of pest control, and also holds the 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 crop production/ crop cycle stage? Related, will household value information service when many of the short-run effects, such as improved micro-nutrients restored (or retained) and improved farm productivity, may not be easily observable or directly valued by households? Moreover, will households choose to invest in information services when much of the information is available locally from other sources, and would they be able to foresee economic returns to improved farm management (beyond technical agriculture) after the completion of crop cycles?

The experiment was conducted in Karnataka, a south-western state of India. In our experimental intervention, samples are drawn from a wider spread of villages to address concerns of information spillovers - randomisation was carried out at the village level.

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, 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 "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

[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.

individuals face limitations on their ability to use, store, or retrieve information (Simon, 1959). It is likely that differences in individuals' capacity to process and assess the value of information lead to variability in consumption patterns, as some individuals will have little ability to use certain information and, thus, weaker demand. Schultz (1979) documents returns to the human capital approach and recognises the economic role of education and experience. He portrays the idea that differences in people's ability to deal with disequilibria drive 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 from noticing key aspects of production, another dimension highlighted the benefits of the design of an 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 the acquisition of additional information (Stiglitz, 1985, 1974), together with the learning of bounded rationality models (Simon, 1959), the 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 through in-person visits and web-enabled tablets to enrich the knowledge-sharing experience and enable easier use, storage and retrieval. It is not a one-off 'hit or miss' provision of supply-driven information. Since August 2013, the web-enabled information experiment has been administering crop-cycle season-wise in the two districts of the Karnataka state in Southern India[3]. In the paper, we, therefore, conceptualise that the need for different types of farm knowledge under different uncertainty contexts in the agricultural sector imparts value to information. Here, the notion of the 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 various forms, depending upon the stage of the cropping cycle, to a specific individual. Unlike previous studies in literature, the paper does not explicitly assess the value of each type of information but rather the customised information package and economic logic underneath it.

The 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 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 and optimal input use and consult directly with farmers on specific production problems,

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[3] In the research set-up, agricultural information service is a unique trial-based 'seed-to-seed' information service given to farmers in their farm fields through extension advisors. As noted earlier, we call it eSAP. By design, it offers a combination of interventions, including *real-time* technical advice throughout the 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) highlight the efficiency gains from various extension modalities.

thus facilitating a shift to more efficient methods of production (Dinar et al., 2007). Studies distinguish the ones that focus on the microeconomics of technology adoption (see Foster and Rosenzweig, 2010 for a survey) from the others that discuss advice or purely e-consulting-based services 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 countries highlight monitoring problems in a principle-agent framework (Anderson and Feder, 2007). For instance, political capture leads government agents to deliver farm information services to an elite group that is associated with the local government rather than to marginal farmers for whom 'incremental benefit of information may be higher'. Cole and Fernando (2012) note that government agents target 'easiest-to-reach farmers' to meet their performance quotas, and the transportation infrastructure in rural areas of India compounds the problem of neglect of farmers in the interior. Agricultural extension is rarely provided to farmers through in-person visits on a cyclical basis, and the inability of farmers to follow up on information delivered limits their scope and intention to adopt new technology.

The main body of research on the effect of extension services relies on estimating production functions that include extension services 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 study methodology will likely provide biased estimates of the impact due to the 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 is offered for six crop seasons in Western Kenya, only 27% of farmers, on average, use fertilizer. The study concludes that the slow rate of fertiliser adoption later was due to farmers having trouble saving harvest income for future fertilizer use. A 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 the total failure of the experiment. The motivation for intervention in the study by Duflo et al. (2006) is mainly focused on fertilizer use, while the possibility of misaligned 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, complete extension service support throughout the crop cycle might gain farmers' 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 the 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) find the significant positive role of a mobile phone-based agricultural consulting service in addressing the problem of imperfect information in agriculture in the state of Gujarat. On the other hand, Fafchamps and Minten (2012), who study the impact of SMS-based agricultural information on farm outcomes in the Indian state of Maharashtra, find 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 spillover issue, the other study does not discuss much on ruling out the possibility of spillovers across farmers in the control and treatment groups. Irrespective of the differences in the findings of the studies, we do not see how authors cope with the usual challenges of identifying the treatment effects systematically that are associated with regard to the use of mobile technology for intervention. These include – selection bias, i.e., establishing a proper counterfactual group in the research and controlling the spillover effects. With access to mobile phones, 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 in 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 addressed or weakly in the existing literature through the designing of the intervention (eSAP). We discuss our intervention's experimental design and description in the next section.

A large body of literature does not use random assignment of extension services but uses control groups of farmers and nonexperimental techniques to address selection bias. For example, Gotland et al. (2004) estimate the 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 programmes in Indonesia, did not find any impact on yields or reduction in the use of pesticides. On the other hand, using a 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 not present for all years nor all the crops studied.

Maffioli et al. (2011), using panel data from grape producers in Argentina, find a negative overall impact of the 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 the 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 eSAP 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 EXPERIMENTAL DESIGN

Selection of project sites and focus crops:

The initial plan was to launch the project in two Talukas in Tumkur District – Gubbi and Kunigal. By then, Gubbi already had 15 common service centres (CSC), and there was a possibility of having additional CSCs in Gubbi and some new ones in Kunigal. As this did not materialize, we considered replacing Kunigal with Turuvekere, another Taluka adjacent to Gubbi. However, field trips (February-March 2012) in Gubbi revealed that this region had been suffering from drought conditions since 2010. Although the Hemavathi canal passes through Gubbi Taluka, the percentage of farmland in Gubbi that comes under its coverage area is low, and it remained almost dry for the last two years due to below-normal rainfall. Moreover, the lack of a perennial river in the area also aggravated the situation. Many farmers lost their crops and were not in a cooperative mood when we approached them to discuss issues related to crop production. Then, we started to look for an alternative Taluka with different agro-climatic conditions and better irrigation facilities so that the study would represent broader agro-climatic zones and the risk of total crop failure during the study period could be reduced.

Another advantage of making Siruguppa one of the project sites is that the study region is now spread over two different agro-climatic zones, with different crops grown, making the study broad and interesting. Gubbi falls in the Eastern dry zone, whereas Siruguppa falls in the Northern dry zone.[6] The annual rainfall in the Northern dry zone ranges from 464.5 to 785.7 mm. About 52% of the annual rainfall is received in the months of September to December. So, Rabi is also a prominent agricultural season here. The soils are shallow to deep black clays in most areas. In Siruguppa, paddy is the major crop, followed by cotton. The annual rainfall in the Eastern dry zone ranges from 679.1 to 888.9 mm. More than 50% of it is received in pre-monsoon and monsoon seasons. As such, it is predominantly a Kharif zone. The soils are red loamy in most areas. In Gubbi, ragi is the major field crop, followed by the red gram.

During this project, the impact of information will be tested on only some selected crops. After selecting project sites, that choice becomes easy. Personal communication with officers and scientists appointed in these regions guided us in selecting paddy, cotton, sunflower, and Bengal gram as focus crops in Siruguppa, and ragi, red gram, and paddy in Gubbi. Although coconut and areca nut are two major crops in Gubbi, we leave these plantation crops because of two reasons. First, personal communication with KVK scientists reveals that it is difficult to ensure that every coconut plot owner is following the best pest control solution offered to them, and it takes only one default for the pest to attack, spread, and eventually damage every plantation stand in a village. So, it is difficult to get all the farmers on board when it comes to developing a damage control strategy. Second, plantation crops have a gestation period before they start producing and then remain productive for years, making analysis hard. Third, a plantation crop owner may have a stand of trees of different ages. This may happen frequently in the case of coconut and areca nut where replantation takes place. Yield (defined as fruits per tree per year) can be considerably different if trees vary significantly in terms of age.

Field trips & Pilot survey:

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[6] Source: http://raitamitra.kar.nic.in/agriprofile/zones.htm

Once, the project sites are finalized, we planned a small-scale pilot survey in both places to collect information on the current 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. The team had designed quite a few short questionnaires to be tested in the field (See Appendix 1). Two data collection methods were employed in Gubbi during the pilot survey phase. Some questionnaires (See Questionnaire # 1 in Appendix 1) were kept at the CSC, and the CSC operator conducted the interviews whenever a farmer visited him/her and agreed to take the survey. However, as the CSC operators were inexperienced in the survey, the questionnaire's quality was unsatisfactory. The other way was to talk to farmers visiting them directly. Ultimately, we had to follow the latter in both places. In Siruguppa, a farmer’s meeting was organized by the Head of the ARS farm. Farmers were interviewed through an interpreter following a short questionnaire. In the process, we have collected information from 44 farmers in Gubbi and 28 farmers in Siruguppa. Some salient observations from the 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). Most of the respondents did not obtain any training on modern agricultural practices, and they did not know where to get such information. Whereas, the officers at those centres would say that they advertise in the 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, the majority of the interviewed farmers were willing to pay if a reliable source could provide agriculture-related information to them.

Non-governmental organisations (NGO) have a strong presence in Gubbi. From the pilot survey, we learned that two of them, Initiatives for Development Foundation (IDF) and Shri Kshetra Dharmasthala Rural Development Project (SKDRDP)—had close ties with farmers. We visited their offices and attended farmer meetings to learn more about their operations.

The IDF requires a minimum of 10 persons (from different families) to form a Self Help Group (SHG) or Joint Liability Group (JLG). A minimum of 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. The 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 lectures 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 with a lot of agricultural information relevant to the local farmer. They give these free of cost to CUTAs. If any farmer wants to buy a personal copy, it is available at INR 50.

The SKDRDP also helps farmers in various ways[7]. The fundamental objective of SKDRDP is the promotion of intensive mixed farming in the area using cost-effective technology to increase income levels. Recently, 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 regularly conducts annual Kissan Melas and organises training, field visits, installation of demonstration plots, etc., for capacity building of farmers registered with them. So, one has to be cautious in order to protect the experiment from any potential spillover effect from their activities. It is 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 with any NGO and their sources of agricultural information.

Mode of treatment:

The team explored two options to provide information to farmers. One option was to put all the relevant information in a tablet and make it available to farmers. The other option was to set up a wide-screen television in CSC and broadcast agricultural programs and videos through it, so that farmers visiting CSC for other purposes could also gather agricultural information. Incidentally, scientists at the UAS Raichur, have developed a unique IT-enabled handheld device, named e-SAP[8] (*Electronic Solutions Against Agricultural Pests*) that will provide farmers with information on pest-related problems in real-time. The team decided to take advantage of this device but feed more content into it so that farmers get wide-ranging information from one single source. More about the tablet and the treatment/intervention are discussed later.

Research design:

The project employs a randomized controlled trial (RCT) to evaluate the impact of providing agricultural information to farmers on farm productivity. RCT is utilized because it is the most efficient method for investigating causality, avoiding selection bias. The methodology can also study the effects of combinations of treatments and the interaction between treatments. Let us elaborate on these points in some detail.

Impact evaluation studies of social programs commonly compare two groups of people – who participated in the program and who did not, with the implication being that the program's intervention causes any difference. Participants in a program may be systematically different from non-participants if participation decisions are left to individuals. For example, consider an optional after-school tutoring program for students. It may attract a disproportionately high

[7] http://www.skdrdpindia.org/pdf%20files/Annual%20Report%202011-12.pdf
[8] http://articles.economictimes.indiatimes.com/2012-12-25/news/35999222_1_pest-management-farmer-tablet

number of students who value education more and thus will have better exam scores even if the particular program is not very effective in raising their performance. In our case, if participation in our extension program is totally left to farmers, then that may attract a number of progressive farmers who are eager to learn and implement new ideas for higher yields than those who are 'average and conservative' farmers. If an agricultural extension program targets struggling farmers, then comparing its participants to other farmers at the same village/GP may be overly favourable (since, as discussed above, its participants may tend to place higher priority on information). The presence of these types of selection bias in evaluation studies will draw criticism on the legitimacy of the evaluation. The RCT method generally avoids this type of bias, as participants who receive treatment are randomly selected.

So far, our discussion on RCTs has focused on comparing two groups, an intervention and a control group, with no interaction effects. However, it is possible to compare more than two treatments provided the groups are independent. Moreover, the interaction between treatments and other environmental factors is possible. If one considers soil types, agro-climatic zones, etc., as environment and RCT options as treatments, one can investigate treatment × environment interaction. If there is no interaction, averaging over environments may identify the best RCT.

The steps to conducting an RCT are: *(1) selecting reference and experimental population; (2) randomization; (3) intervention; (4) follow up; and (5) assessment*. What follows next is the detailed description of steps 1 to 3.

The reference or target population is the population to which the trial's findings, if found successful, are expected to be applicable. The experimental or study population is the population that participates in the experimental study. The reference population has already been selected as the field crop farmers in Gubbi and Siruguppa Taluka. The next task is to choose the farmers participating in the experiment. Randomization tends to allocate participants into study groups (control and treatment) comparable with respect to known and unknown factors, removes investigator bias in allocating subjects and guarantees that statistical tests will have validity. Different research designs have been developed for two project sites depending on the research objective. So, we would discuss them one by one.

Summary of sample design

Taluk (sub-district) selected – Gubbi and Siriguppa
Total GP (Gram Panchayat) - 58
Total villages – 412
Total GPs in Gubbi – 33
Total villages in Gubbi - 328
Total GPs in Siriguppa – 25
Total villages in Siriguppa - 84
Selected villages – 205

Treatment villages – 102
Control villages – 103
Total households selected – 1320
Total households selected in Gubbi – 660
Total households selected in Siriguppa – 660
Control households in Gubbi – 300
Treatment household in Gubbi – 300
Spillover households in Gubbi – 60
Control households in Siriguppa – 300
Treatment household in Siriguppa – 300
Spillover households in Siriguppa – 60

Gubbi: We applied a *two-stage* procedure with randomisation carried out at the village level. randomly selecting the village first and then the households. In the first stage, half of the villages were randomly allocated to treatment while the other half to control. Typically, a *Gram Panchayat* (GP) consists of 5 or more villages. Randomization is done in Excel. A similar condition is applied in random sampling: none of the control and treatment villages is from the two neighbouring GPs. However, two treatment and two control villages can be from two neighbouring GPs. Figure 3 is a schematic depiction of the stages and the GP sample chosen in the process. Figure 4 depicts the location of GPs and villages in Gubbi Taluka and their classification into treatment and control groups.

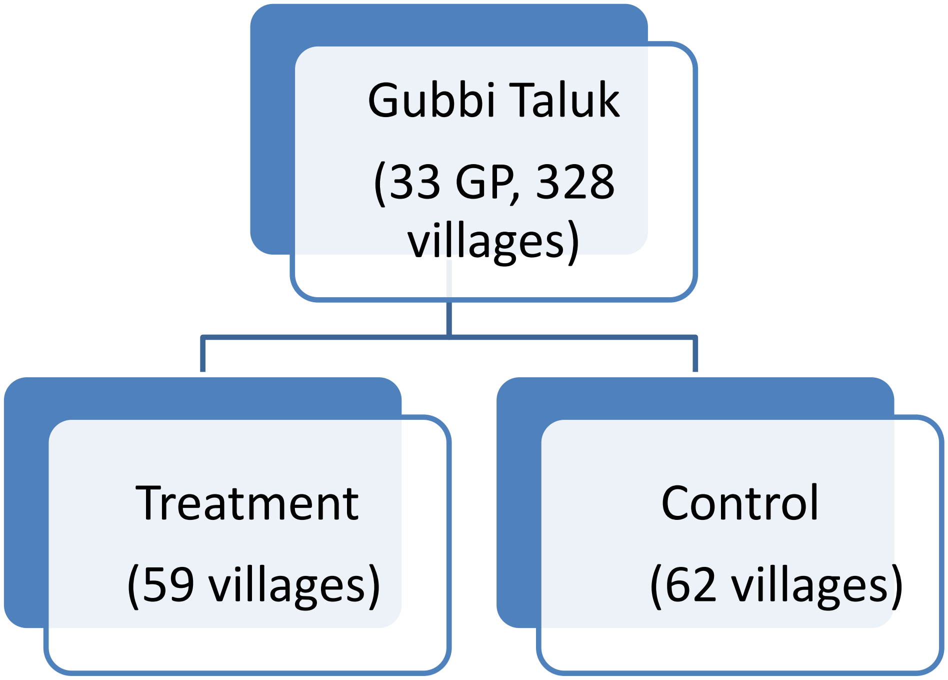
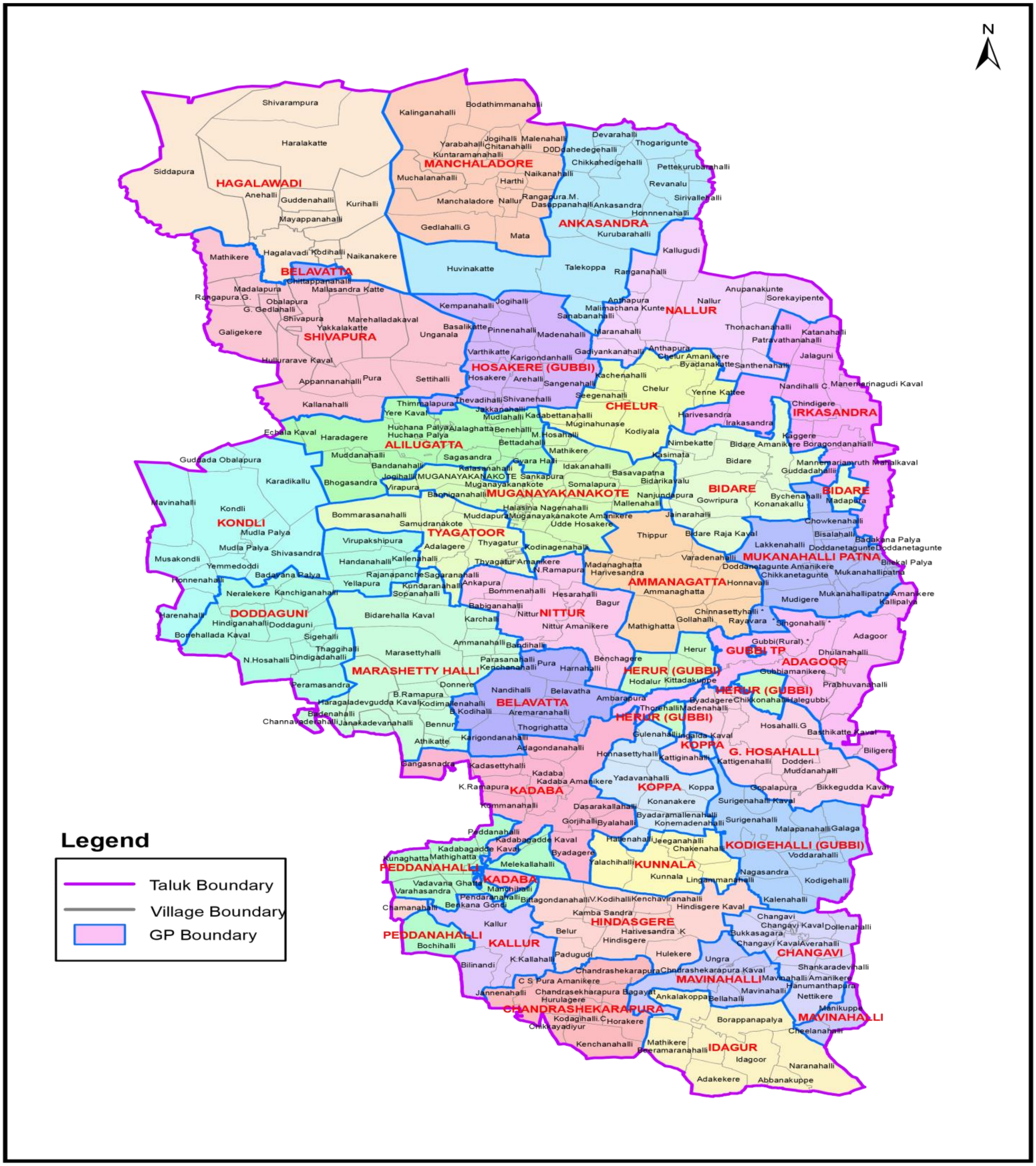


Fig.1 Selection of gram panchayat (GP) and allocation in control and treatment groups in Gubbi

Fig.2 Map of treatment and control gram panchayats in Gubbi



List of treatment and control villages

List of treatment villages	List of control villages
1. Anthapura	1. Bidare
2. Anupanakunte	2. Bidare Amanikere
3. Byadanakatte	3. Bidare Raja Kaval
4. Gadiyankanahalli	4. Gowripura
5. Kallugudi	5. Guddadahallii
6. Malimachana Kunte	6. Jainarahalli
7. Maranahalli	7. Kasimata
8. Nallur	8. Konanakallu
9. Ranganahalli	9. Madapura
10. Santhenahalli	10. Nimbekatte
11. Sorekayipente	11. Bellahalli
12. Thonachanahalli	12. Cheelanahalli
13. Arehalli	13. Hanumanthapura
14. Hosakere	14. Manikuppe
15. Jogihalli	15. Mavinahalli
16. Karigondanahalli	16. Mavinahalli Amanikere
17. Kempanahalli	17. Ungra
18. Madenahalli	18. Bochihalli
19. Pinnenahalli	19. Chamanahalli
20. Sangenahalli	20.Kunaghatta
21. Shivanehalli	21.Manchihalli
22. Thevadihalli	22.Mathighatta
23. Thimmalapura	23.Melekallahalli
24. Varthikatte	24.Peddanahalli
25. Byadaramallenahalli	25.Pendaranahalli
26. Gulenahalli	26.Vadavana Ghatta
27. Hallenahalli	27.Varahasandra
28. Honnasettyhalli	28.Amanikere
29. Ingalda Kaval	29.Chandrasekharapura Bagayat
30. Konanakere	30.Chandrashekarapura
31. Konemadenahalli	31.Chikkayadiyur
32. Koppa	32.Horakere
33. Yadavanahalli	33.Hurulagere
34. Guddada Obalapura	34.Jannenahalli
35. Harenahalli	35.Kenchanahalli
36. Honnenahalli	36.Kodagihalli.c
37. Kondli	37.Badakana Palya
38. Mavinahalli	38.Bilekal Palya
39. Mudla Palya	39.Bisalahalli

40. Musakondli	40.Bychenahalli
41. Shivasandra	41.Chikkanetagunte
42. Yemmedoddi	42.Chowkenahalli
43. Ankapura	43.Doddanetagunte
44. Babiganahalli	44.Lakkenahalli
45. Bagur	45.Mudigere
46. Benchagere	46.Mukanahallipatna
47. Bommenahalli	47.Mukanahallipatna Amanikere
48. Hesarahalli	48Rayavara
49. N.ramapura	49.Bodathimmanahalli
50. Nittur	50.Chittappanahalli
51. Nittur Amanikere	51.Gedlahalli.g
52. Galaga	52.Harthi
53. Kalenahalli	53.Jogihalli
54. Kodigehalli	54.Kalinganahalli
55. Malapanahalli	55.Kuntaramanahalli
56. Nagasandra	56.Malenahalli
57. Surigenahalli	57.Manchaladore
58. Surigenahalli Kaval	58.Mata
59. Voddarahalli	59.Muchalanahalli
	60.Nallur
	61.Rangapura.m.
	62.Yarabahalli

List of villages from which spillover households are randomly selected.

Villages (43)	Number of farmers
Anthapura	1
Anupanakunte	2
Bagur	1
Benachigere	1
Bommanahalli	1
Byatappanapalya	1
Gadiyankanahalli	1
Galaga	2
Golenahalli	2
Halenahalli	1
Hesarahalli	2
Honnashettihalli	1
Hosakere	2
Kalenahalli	1

Konankere	1
Konemadenahalli	1
Koppa	2
Madenahalli	2
Marnahalli	2
N.Mattighatta	1
N.Rampura	2
Nagasandara	1
Nallur	1
Nittur Amanikere	1
Pennahalli	1
Pinnenahalli	1
S.Kodagihalli	2
Sanganahalli	2
Shivanahalli	1
Surigenahalli	1
Tevadehalli	2
Tonachinahalli	2
Vaddarahalli	1
Yadavanahalli	2
Yemmedoddi	1
Harenahalli	2
Honnenahalli	2
Mavinahalli	1
mudla palya	1
Guddada Obalapura	1
Sathenahalli	1
shivasandra	2
Sorekayipente	1

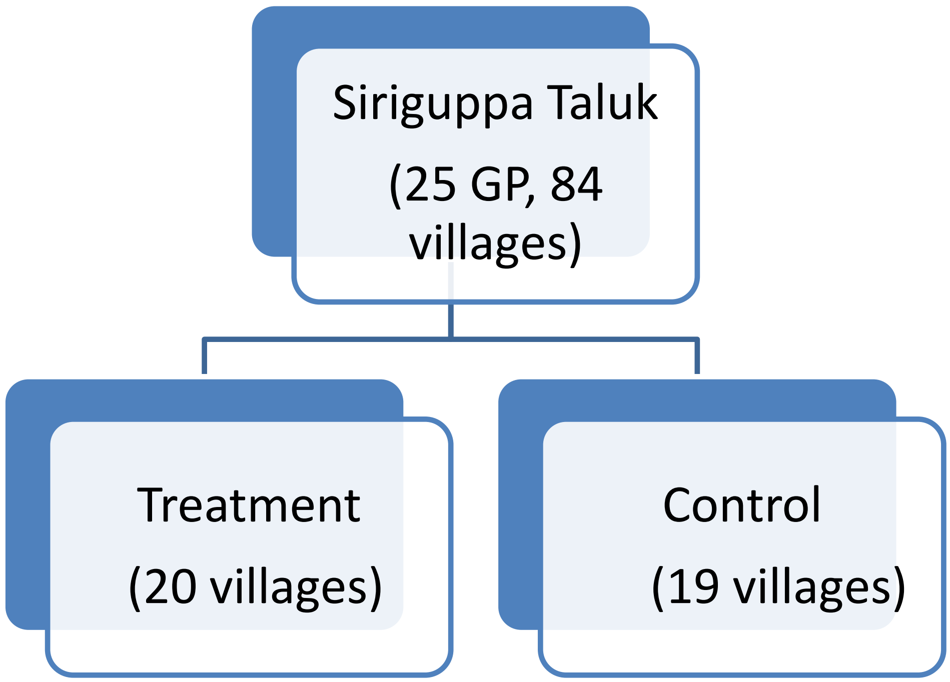
Siruguppa: We applied the same *two-stage* procedure with randomisation carried out at the village level (random selection of the village first and then the households). In the first stage, half of the villages were randomly allocated to treatment while the other half to control. Typically, a *Gram Panchayat* (GP) consists of 2 or more villages, and the selected Siriguppa *Taluk* from which the samples are drawn consists of 25 GPs. From the 84 villages in Siriguppa, we randomly chose 19 villages as control and 20 as treatment. Randomization is done in Excel. A similar condition is applied in random sampling: none of the control and treatment villages are from the two neighbouring GPs. However, two treatments and two control villages can be from neighbouring GPs. Figure 3 is a schematic depiction of the stages and the GP sample chosen in the process. Figure 4 depicts the location of GPs and villages in Siruguppa Taluka and their classification into treatment and control groups.

For Siruguppa, we applied the same two-stage randomization procedure: selection of the village and then the households. From 84 villages in 25 GP in Siruguppa, 19 villages are randomly chosen as control and 20 as treatment. Randomization is done in Excel. A similar condition is applied in random sampling: None of the control and treatment villages is from the two neighbouring GPs; however, two treatment and two control villages can be from the two neighbouring GPs. Figure 3 is a schematic depiction of the stages and the GP sample chosen in the process. Figure 4 depicts the location of GPs and villages in Siruguppa Taluka and their classification into treatment and control groups.

Another interesting research question which can be addressed is the magnitude of the spillover effect. It has been observed in the field that farmers often collect information from other farmers in the village. Thus, farmers may pass the information provided by e-SAP and our extension agent to others in the village, and the recipients may benefit as well. To measure this indirect benefit, it is decided to take some additional farmers in randomly chosen treatment villages (60 households from each taluka). They will not receive any direct information from the project, but they will be surveyed.

The subsequent question was how these additional farmers would be chosen. To capture the internal (intra-village) spillover effect, for each treated village, select 2 or more additional farmers from the village itself. To capture the external (inter-village) spillover effect, select two more from outside the village for each treated village. But, as GP in Siruguppa has a smaller number of villages (sometimes only one village), they are bigger, too. So, it was decided that farmers should be selected randomly from the treatment villages, ignoring their village of residence. Ideally, these farmers should be chosen simultaneously with the farmers receiving treatment. However, a randomly selected and identified farmer may refuse to respond to our survey. Considering that possibility, it was decided that those 60 farmers would be chosen randomly after completing the baseline survey in a treatment GP.

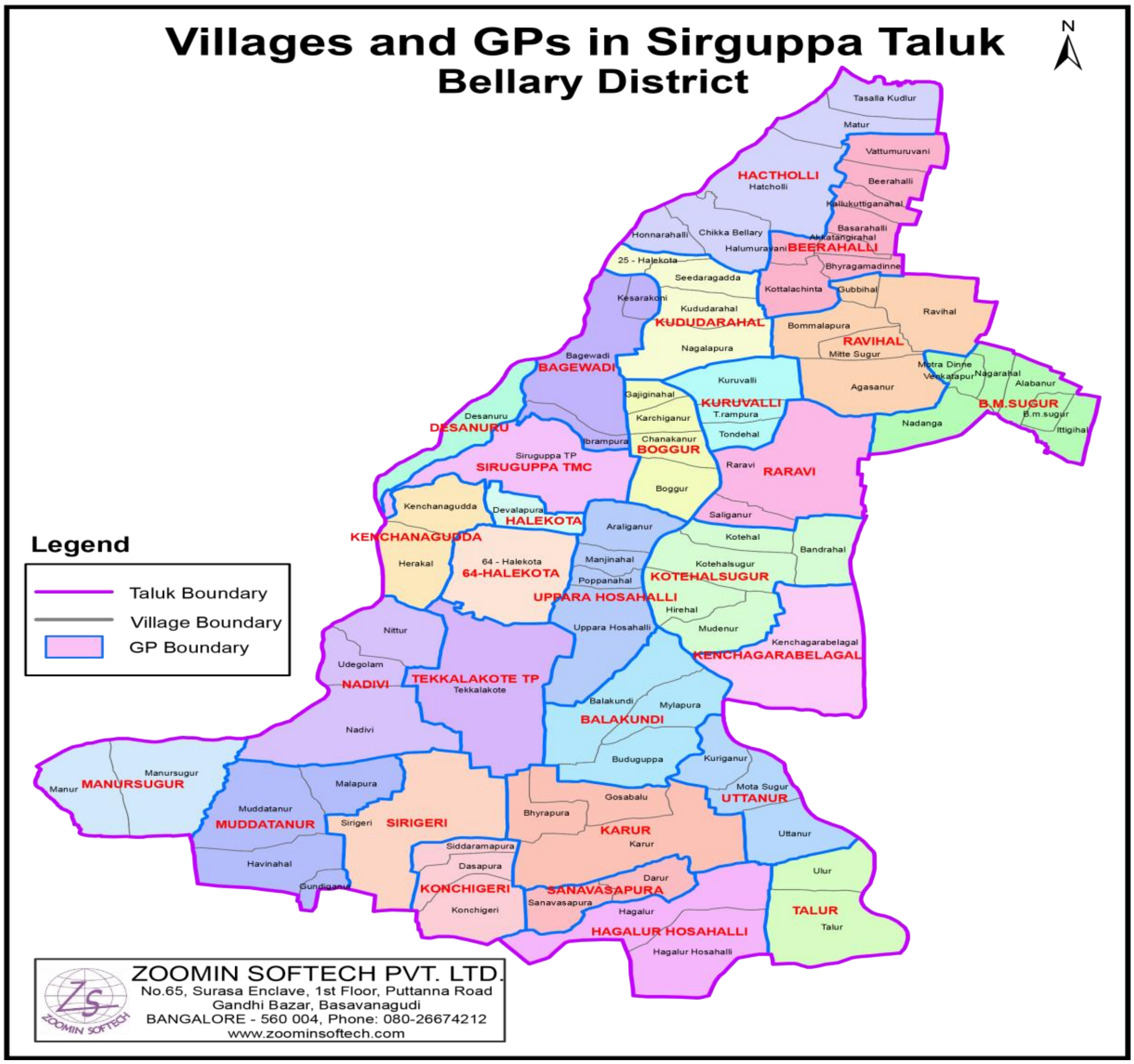
Fig.3 Allocation of villages in control and treatment groups in Siruguppa



List of treatment villages	List of control villages
1. Agasanur	1.Bagawady
2.Alabanur	2.Banche Camp
3.B M Sugur	3.Bandrahal
4.Bommalapura	4.Bhyrapura
5.Devalapura	5.Boggur
6.Halekota	6.Chanakanur
7.Herakal	7.Chikka Bellary
8.Itagihal	8.Gajiginahal
9.Kenchanagudda	9.Gosabalu
10.Manur	10.Hatcholli
11.Manur Sugur	11.Hirehal
12.Mitte Sugur	12.Honnarahalli
13.Nadanga	13.Ibrampura
14.Nagarahal	14. Karchiganur

15.Ravihal	15. Karur
16.Siddarampura	16.Kotehal
17.Talur	17.Kotehalsugur
18.Ullur	18.Matur
19.Venkatapur	19.Modenur
	20.Sirigeri

Fig.4 Map of treatment and control gram panchayats in Siruguppa



List of villages from which spillover households are randomly selected

Villages (18)	Number of households
Bagawady	5
Bandrahal	2
Bhyrapura	4
Boggur	4
Chanakanur	3
Chikka Bellary	2
Gajiginahal	1
Gosabalu	4
Hatcholli	3
Hirehal	2
Honnarahalli	2
Ibrampura	5
Karchiganur	2
Karur	2
Kotehalsugur	3
Matur	3
Modenur	3
Sirigeri	10

Sample size calculation:

An RCT should have sufficient statistical power to detect differences between treatment and control groups. Therefore, calculating sample size with provision for adequate levels of significance and power is an essential part of planning, and this is precisely what we are going to discuss next. Surprisingly, none of the RCT papers in Economic journals mention this issue.

A standard formula is used for sample size calculation. The assumption behind this formula is: (i) one control & one treatment group of the same size; and (ii) standard deviation of the variable of interest is constant across the groups. Different versions of the formula can be found in applied work (Eng, 2003; Wittes, 2002; Zhong, 2009). Sample size in each group is given by

$$n = 2s^2 \left[\frac{z_C + z_P}{\Delta}\right]^2$$

where s denotes pulled standard deviation of both comparison groups, z is 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 have to make some additional assumptions to get crop-specific *n* values for our project sites. Suppose, we want to achieve 80% power and 95% significance level for our analysis, then the critical Z_C is 1.96 and critical Z_P is 0.845. The final assumption is about the magnitude of the mean difference Δ. The true value of Δ is unknown. It is up to the researcher to fix the effect size that s/he wants to test statistically. Frontline demonstration (FLD) records can help to make an educated guess. 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 intervention. The team approached two KVKs in charge of carrying out FLD in the project sites. After some effort, the aggregated summary report on FLD was obtained from only Tiptur KVK[9] which caters to the Tumkur District. Table 1 provides a summary picture of FLD on some major crops in Gubbi. The minimum increase in yield observed is 10.2%, so an effect size of 10% seems a reasonable choice. For crop and site-specific sample size calculation, we have carried out two sets of analysis utilizing data from two sources. What follows next is the description of these two sets of calculations.

Table 1: A glimpse of the FLD results on three focus crops (Source: See footnote 3)

Season: 2010-11 Kharif					
Crop	Variety	Condition[10]	No. of FLD	Check yield (q/ha)	Increase
Redgram	BRG-1	rf	32	9.6	14.2%
Paddy	BR-2655	ir	18	52.1	17.7%
Paddy	Tanu	ir	16	52.2	17.7%
Ragi	MR-6	rf	10	16.5	19.3%
Ragi	GPU-48	rf	5	14.7	11.8%
Ragi	ML-365	rf	5	16.6	15.9%
Ragi	KMR-301	rf	5	16.6	12.9%
Season: 2011-12 Kharif					
Crop	Variety	Condition	No. of FLD	Check yield (q/ha)	Increase
Redgram	BRG-1	rf	26	10	15%
Paddy	BR-2655	rf	18	50.5	15.3%
Paddy	Tanu	rf	19	58.4	15.8%
Ragi	ML-365	rf	18	19.5	10.2%
Ragi	KMR-301	rf	13	19.5	10.2%

First, we have used information gathered through the pilot survey. Although 44 and 28 responses were received from Gubbi and Siruguppa respectively, not all these farmers have grown our focus crops. So, the analysis of crop-specific sample size requirements is plagued by few observations. We have not calculated if the number of observations for a crop is less than five. Table 2 shows the number of observations used, mean and standard deviation of yield (in quintal/acre) and sample size required for control and treatment groups.

[9] Source: Annual Progress Reports, KVK Tumkur, UAS Bangalore. Contact person: Dr. Sujith (9449866936)

[10] Field condition: rf = rainfed; ir = irrigated.

Table 2: Sample size calculation using pilot survey data

GUBBI	*No. of obs.*	*Avg. yield (q/ac)*	*Std. dev. (q/ac)*	*Sample size (n)*
Ragi (ir)	8	11.58	4.36	222
Ragi (rf)	16	4.90	3.17	656
Paddy (ir)	6	26.61	7.31	12
SIRUGUPPA				
Paddy (ir)	17	28.88	3.64	25
Cotton (ir)	9	17.11	4.73	120
Cotton (rf)	9	8.33	4.66	490

Unsatisfied with the reliability of the analysis, we have tried the secondary data source. The Agriculture Insurance Company of India (AIC) keeps crop-cutting experiment data available at the Hobli level and crop-wise and season-wise. Few data points exist from Gubbi and Siruguppa Talukas. If data from the study region is unavailable, then for power calculations, data from a similar region can be used. Following the suggestion, we have collected crop yield data from Talukas, neighbouring Gubbi and Siruguppa for 2010 and 2011. Thus, the agro-climatic condition remains more or less the same in the sample. The most recent year's data were used, and the results are presented in Table 3.

Table 3: Sample size calculation using pilot AIC data

GUBBI	*No. of obs.*	*Avg. yield (q/ac)*	*Std. dev. (q/ac)*	*Sample size (n)*
Ragi (ir)	12	11.58	1.68	34
Ragi (rf)	34	8.77	2.59	137
Paddy (ir)	17	12.93	1.65	26
Redgram (rf)	9	3.14	0.77	95
SIRUGUPPA				
Paddy (ir)	33	16.22	3.57	77
Sunflower (ir)	28	4.14	0.99	90
Sunflower (rf)	31	1.39	0.66	353

Based on the above sample size computations, the team decided to have 300 farmers each in the control and treatment group in both project sites, hoping that we will get sufficient farmers to attain satisfactory power for most of our focus crops. Three hundred farmers should be equally distributed in all GPs. Thus, 50 farmers are to be surveyed for each GP. To measure the intra-GP spillover effect, 10 additional farmers were chosen for each treatment GP. They will not receive direct treatment from the project but will be surveyed.

Baseline questionnaire and farmer's diary:

The next task at hand was to design the questionnaire for the baseline survey. A literature review related to the research questions helped us figure out important variables on which data could be collected. The first draft of the questionnaire had four sections: farmer details, agriculture, information and social network, and household details. In May, we recruited six B.Sc.

(Agriculture) graduates as enumerators and arranged a mock survey in a village nearby. As the project would like to collect detailed data on agricultural operations and household consumption during the timeframe of the project, a farmer's diary was also developed after consulting one such diary designed by an NGO. We will start the fieldwork in May 2013.

Farmer identification:

The next endeavour was to collect lists containing all farmers in Gubbi and Siruguppa. We started with Gubbi, where we had four alternative sources from which to choose. We tried each one of them. *First*, one could collect the names of those farmers who have purchased seeds from RSK. Lists were collected from each RSK in Gubbi Taluka. These lists had the crop name a farmer had grown or intending to grow. However, this type of register is not a comprehensive list of farmers as not all farmers go to collect subsidized seeds and fertilizers from RSK. For example, although Kondli GP is in the working area of Nittur RSK, we found that not even 100 farmers from Kondli GP are registered in Nittur RSK. The actual farmer population is over 2,000 in Kondli, per the revenue inspector for Kondli. These RSK lists mostly contain small and marginal farmers. Some names from these lists were tried for identification in the field, and in 80% of cases, we found the farmer. *Second*, the Tahasheeldar's office in Gubbi pointed out that HDFC Bank had a list of farmers who got subsidies or benefits from the government. That list was collected, too. Although it had almost 27,000 names in it, some Gubbi villages were not listed there, and also, for some villages, very few farmer names were available. Thus, that list was not a comprehensive list of farmers. *Third*, Panchatantra – database of online records of panchayats, stores list of households in villages. This is a comprehensive and accurate list but only lists the names of household heads who may or may not be farmers. So, if we draw a random sample from that list, some samples would be wasted. *Fourth*, a source for a comprehensive farmers list is the Bhoomi, the government project of online delivery and management of land records in Karnataka. The farmland owner list can be generated through special online software, but the Tahasheeldar office does not have that facility. They provided contacts for a private contractor with an SQL database of more than 33,000 farmland owner names and their land holdings in Gubbi for 2011-12. That was the best possible list we could have obtained.

The next step was to draw a random sample of farmland owners from the Bhoomi database and their identification. A standard definition of household was followed, viz., it consists of one or more people who live in the same dwelling and also share meals or living accommodation. In this phase of the survey, first, the team of enumerators visited villages more than once to check the existence of each randomly chosen farmer, collecting their phone numbers and information on crops grown last year, and checking the splitting of households. In some cases, they found that a household was split between brothers, but the land was in their father's or grandfather's name, per the Bhoomi database. In those cases, the enumerators had listed those brothers who had grown any of our focus crops in 2012.

However, several other practical problems remained. For example, the randomly selected farmer had sold off his land recently or did not grow any of the focus crops. In the identification phase, many farmers were matched, but they had plantation crops only. It may be the case that land rights are in someone's name and that person had expired, but land ownership did not change in the government database. Some very small and marginal farmers live in their farms where contact with the rest of the world is poor, creating an impediment to identification. In addition, even if a farmer is identified, he may not stay in the same village where he owns the piece of land.

In such cases, identifying all the farmers from a randomly drawn list seemed difficult. To overcome this problem, 50% over-sample of farmer names was taken for each GP for identification. Therefore, we started identification with an additional 25 and 30 names for control and treatment GPs, respectively. We often failed to meet the target figure even after 50% oversampling. For example, (i) in Mavinahalli (Control GP), we identified 36 farmers when the target was 50, and (ii) in Nittur (Treatment GP), we found 47 farmers when the target was 60. In few cases, we found a higher number of matches as well. For example, (i) in Manchaldore (Control GP), we were able to identify 54 farmers when the target was 50, and (ii) in Nallur (Treatment GP), we found 74 farmers when the target was 60. Table 4 depicts a summary of the identification in Gubbi. The farmer's phone number was noted during the identification, when available so that he could be traced easily for the next round.

In Siruguppa, we followed the Bhoomi database to draw a random sample of farmers. A list of more than 27,000 landowner names for the year 2012-13 had been collected from the Tahsheeldar's office. We followed the same 50% over-sample strategy. Siruguppa Taluk has appointed gram sahayak (or, Talwar) for its villages. In most of the cases, we found him or his son in the village during our trip. They were instrumental in getting a relatively better match compared to Gubbi. In some cases, help was obtained from a panchayat officer. Some important observations in Siruguppa: (i) villages are more compact with better landmarks; (ii) absentee landlord-ship is an issue (farmer's name is identified, but he is a big farmer staying in city – Bellary, Adoni, or Siruguppa); (iii) Some GPs have experienced repeated floods in the past, resulting into migration of farmers to urban area; (iv) some big farmers (> 50 acres) who are not willing to participate in survey. While the first fact helps in identification, the others don't. For example, in Kesarkoni (Bagewadi GP), Honarahalli and T.S. Kudlur (Hatcholli GP), the success rate of matching is around 10%. In this case, other farmers have been approached randomly in the field and are included in the list depending on their willingness to take the survey. In the case of overmatching, we discarded extra farmers randomly but kept them as a backup if needed in the future. Refer to Table 4 for the summary picture of identification in Siruguppa. Farmer's phone number and landmark were noted down during the identification period so that he could be traced easily for the next round.

Table 4: Distribution of farmers across GPs at various stages of survey and experiment

Gubbi GP	**Farmers identified**	**No. remained in final sample**	**Siruguppa GP**	**Farmers identified**	**No. remained in final sample**
Control			*Control*		
Bidare	50		Halekota	54	
Mavinahalli	36		Kenchanagudda	47	
Peddanahalli	45		Ravihal	55	
C.S. Pura	44		B.M. Sugur	53	
M.H. Patna	51		Talur	47	
Manchaldore	54		Manur Sugur	49	
Treatment			*Treatment*		
Nallur	74		Hatcholli	54	
Hosakere	51		Bagewadi	48	
Koppa	???		Baggur	62	
Kondli	42		Kotehal Sugur	58	
Nittur	56		Karur	59	
S. Kodigahalli	54		Sirigeri	57	

The project required a list of progressive farmers to address the 'learning from progressive farmers in your village' question (3.12) in the questionnaire. In Gubbi, search for farmers who have taken FLD or agricultural training has remained futile. The office of Assistant Director of Agriculture (ADA) has provided a list of around 80 farmers who are registered to receive SMS from them on various issues. Though this was not the best list, we used it as the second-best. Some of the villages that came under the survey did not have such a farmer. In Siruguppa, however, we collected lists from multiple sources – office of Assistant Director of Agriculture (ADA), RSK, and ARS. First, the ADA has provided a list of around 150 farmers who have been selected for FLD on foxtail millet (INSIMP project) and paddy. Second, RSK officers provided list of farmers who was hosted farmer field schools (FFS) and FLD in their land. Third, ARS scientist also provided the names of some farmers who visited ARS on a regular basis to learn about best management practices. Names from all possible sources have been compiled. However, some of the villages that come under survey do not have such a farmer.

Baseline survey:

The baseline survey started in the first week of June in Gubbi. In Siruguppa we were late to start the identification, so the baseline survey started in the last week of July. The farmers were given an introduction letter, a farmer's diary, and a pen in a plastic folder as a token of appreciation for participating in the survey. The total value of this gift packet is around $1.5. During the survey, some of the identified farmers refused to cooperate. It was decided to take their replacements from backward communities (Muslims, Scheduled Caste, and Scheduled Tribe) wherever possible. They have been selected randomly in the field and were included in the list depending on their willingness to take the survey. See Table 4 for a final picture of the oversampling required for this project.

The initial baseline questionnaire provided three ‘willingness to pay (WTP)’ prices (Rs 300, Rs. 150, and Rs. 100 for e-SAP service) as an option to the farmer. During the baseline survey, the team decided to get farmer responses on a wide range of to get variations in the data. In Gubbi, three new price sets were introduced: {300, 200, 100}, {250, 150, 50}, and {200, 100, 50}. In Siruguppa, three alternative price sets had been used: {500, 350, 150}, {400, 250, 100}, and {300, 200, 100}. In Siruggupa, some high WTP prices were asked as pilot survey and identification work revealed that farmers were richer compared to those in Gubbi, and many of them could afford to pay a higher price for the same service if they liked it. After these price sets were written in the proper place of the questionnaire by different individuals, all questionnaires were rearranged to maintain randomness. Thus, a farmer facing a particular price set became purely random. It is also important to note that many farmers showed disinterest towards filling in diaries citing various reasons including illiteracy, lack of motivation etc.

Content in e-SAP:

When the team first considered e-SAP as a medium of information dissemination, it only had pest and disease management modules for a couple of crops in it. From our focus crops, we already had fully developed material on pest and disease diagnosis and control for paddy and redgram. However, the e-SAP team was committed to expanding its range of crops. By August 15, they have developed material for pest and disease management of all our focus crops[11] except for ragi. The tablet will contain a standard package of practices for various crops (Source: UAS).

Ragi is a hardy crop which is not prone to many pest and disease problems compared to other crops. There is not much information on pests and diseases in ragi as well. Personal communication with Dr. Prakash, UAS Bangalore, and the package of practices book provided some information, but they were inadequate to fulfil the requirements of the e-SAP team to develop the content for ragi, particularly appropriate pictures. They proposed that during this Kharif season, they would collect photos of diseased ragi plants, get them diagnosed, and from that effort would develop the content on ragi. So, currently, the standard package of practice published by UAS Bangalore would be used to advise farmers on ragi.

The last couple of month’s research effort yielded some content on dairy animals as well. The team explored multiple sources to find good-quality information on dairy animal diseases and their solutions. Video publications from the Rajiv Gandhi College of Veterinary and Animal Sciences and the Shramajeevi Agri Films were consulted, but none of them seemed to be perfect for our purpose. The team has contacted Dr. Prahlad (Veterinary Scientist, UAS-R) for help. He

[11] Paddy, Ragi, Cotton, Redgram, Bengal gram, and Sunflower.

also provided some material. Later, Mr. Srinivasa got good quality video clips from Mr. Ambrish, Srishti Media.

Although we had to start the intervention with the existing material, the plan was to provide wide-ranging information to farmers which are relevant to his business. Broadly speaking, the team has thought of *four* modules in the tab: (i) nutrient management, (ii) plant and animal protection, (iii) crop agronomy, and (iv) market. The e-SAP team will continue to work and plan to release material in the near future. What follows next is the description of these modules. In the nutrient management module, information on crop nutrition and soil nutrition will be provided. As the majority of the farmers have already applied fertilizer in their fields, we have to wait until the end of this Kharif season to collect soil samples. One can collect soil samples per the directions and send them to an established laboratory for testing. Another possibility is taking a mobile soil testing laboratory to villages and doing the testing there. Then, farmers would be advised on the nutritional requirements of their soil. However, nothing has been finalized yet. We are also exploring how to add material on livestock nutrition. The National Dairy Development Board (NDDB) has developed a ration formula for dairy animals, which could be fed to the tablet as well. The second of the conceived modules is already there on the tablet. The third module, agronomy, will encompass information on crop rotation, plant variety, irrigation and drainage, meteorology, and weed control. The fourth module (market) will deliver information on prices for farmer's produce in nearby markets, government schemes on agricultural loans and insurance, and the procedures to apply for them.

Field experience tells us that there is a demand for information on various field crops. For example, some selected farmers in Siruguppa and Gubbi cultivate groundnuts and may require information on that crop. Although we are not studying the impact of our service on all crops that a farmer grows, the project will still supply this demand-based information. Material is readily available on more than 10 crops like groundnut, pigeon pea, chilli, sugarcane etc. Although we have left out plantation crops for impact evaluation, the e-SAP will try to put together information on coconut and areca nuts and supply them to farmers. The Coconut Development Board will be contacted soon to see whether they could provide useful material or not.

Extension through e-SAP:

Developed by Tene Agricultural Solutions (TAS), a leading Indian agri-tech firm, the Electronic Solutions Against Agricultural Pests (eSAP) seamlessly integrates AI into crop production. Using advanced algorithms, eSAP analyses farm data detects growth patterns and predicts crop health—providing early insights into AI's economic impact on agriculture. Initially designed as a diagnostic tool for pest and disease identification, it has evolved into a fully integrated crop management system. With its ability to autonomously learn patterns, detect anomalies, and deliver real-time solutions, eSAP empowers farmers with unprecedented precision, efficiency, and sustainability in agricultural practices.

The primary objective of eSAP is to leverage cutting-edge agricultural technology to maximize farm productivity through innovative, data-driven approaches. By utilizing its vast crop-level database—which encompasses technology insights, pest and disease profiles, and farmer responses—eSAP benchmarks each farmer's initial practices to provide a customized roadmap for improvement. Its dynamically personalized content adapts to the farmer's experience level, rate of progress, and specific farm conditions, ensuring tailored guidance.

Research has consistently demonstrated that localized, individualized advice is significantly more effective than broad, centrally planned recommendations. To maximize accessibility, eSAP delivers information through multiple channels, including on-farm consultations, call centres, and self-guided animations, and is deployable both online and offline via computers, tablets, and smartphones.

At the time of the study, eSAP supported over 100,000 farmers in the neighbouring districts of Karnataka and deployed them to provide information for only a few crops. With the rollout of our project, TAS began to expand its crop pests and disease information database to over 26 major crops grown widely in the state. According to FAO, plant pests and diseases are the foremost emergencies responsible for 20-40% of global food production losses. It poses a significant threat to the livelihoods of vulnerable farmers in developing countries and global food security. Though farmers face constraints such as access to credit, insurance, and input and output markets, we focus this study on access to information on crop cultivation practices in the presence of all other constraints.

2.2. eSAP software: The interactive software includes continuous crop assessment alongside instructional videos and animation from which farmers learn through explanations and feedback. Here, we highlight four critical design features of the software and provide a more detailed pictorial description with examples in the Appendix.

First, despite the many pest management options available, identifying problems and finding solutions is challenging for the different pests and issues that harm crops, such as insects, viruses, fungi, bacteria, weeds, and nutrient deficiencies. All of these reduce crop yields and affect farmers' well-being. The AI-powered content incorporates the latest research on effective crop and soil health management and real-time field monitoring, with built-in intelligence that supports decision-making based on accurate, verifiable data.

Second, the eSAP system employs an adaptive framework, delivering tailored solutions based on each farmer's crop performance. This dynamic adaptation process is initiated at the onset of the crop cycle through a comprehensive diagnostic assessment and continues to refine its recommendations with each subsequent agricultural activity. The pest identification module utilizes an advanced image-based branching model integrated with a machine learning system that continuously improves through statistical learning. A key software innovation lies in its capacity to provide precise, pest-specific diagnoses, enabling farmers to quantify damage accurately and determine the economic threshold for optimal pest management. By delivering targeted advisory support through its “Extension at the Right Level” approach, eSAP effectively mitigates the diverse pest and disease challenges encountered in Karnataka’s major crops, enhancing resilience and productivity.

Third, eSAP enables real-time monitoring of the crop field by integrating the spatial coordinates of the field to the GIS map along with the severity of the problem. The application is built on a platform that opens a gateway for the two-way dissemination of information in real-time. It has substantial built-in intelligence for on-field decision support and protocols for intelligent surveys to gather crop growth-related information for streams-in to be viewed over the GIS platform. As surveillance entails multiple images captured by the field device, a set of close-ups and field images, along with data on the crop, crop age, pest damage, and geo-coordinates of the field, are transmitted to the cloud for further use by researchers and policymakers.

Finally, high-quality images that characterize crops at various stages are adopted to guide users in intuitively identifying any concerns in crop health. Audio assistance in the local language is provided at every step; the user need not be literate. The interactive user interface, combined with the individualization of material for each farmer, facilitates the farmer's continuous engagement with the prevailing crop health management strategies. This approach aims to boost farmer attention and engagement, provide feedback at the level of each intermediate step in solving a problem, and shorten the feedback loop between farmers facing similar pests and diseases.

The team discussed two alternative plans for the extension program with e-SAP. In each case, the chosen farmers will be requested to be present at their farm on a specific day and time, thus making field visits a routine activity. According to the first plan, the project will provide extension services to selected farmers on a weekly basis by visiting their farms. Then, we will require a minimum of two extension agents with individual motorbikes, working six days per week, from 8 am to 5 pm. Each agent will be in charge of three GPs i.e. 150 farmers to be covered in six days. Prior experience from UAS-R extension work with the tab suggests 15 minutes to be the minimum time requirement per visit. Ideally, they will cover 25 farmers per day, accumulating roughly 6.5 hours. The rest of the time is reserved for travel and breaks. However, this model may not work well in Siruguppa because farmers have larger land holdings and travelling may occupy a larger chunk of working hours.

According to the second plan, the project will provide extension services to selected farmers on a bi-weekly basis by visiting their farms. We will require a minimum of two extension agents with individual motorbikes, working six days per week, from 8:30 am to 5 pm. Each agent will be in charge of three GPs, i.e., 150 farmers, who will be covered in six days. We allocate 30 minutes per farm visit. After providing the usual extension service, the agent will collect data on agricultural operations, which the farmers are supposed to fill in the diary provided. The agent can ask the farmer to bring the diary along with him/her to see whether they are recording the data or not. Ideally, they will cover 12 or 13 farmers per day, accumulating roughly 6 hours. The rest of the time is reserved for travel and breaks.

If there is a problem with the crop, the extension agent will first try to diagnose it with the help of the material in the tablet. In the case of diagnosis, the agent will also suggest remedial actions. However, if he is not sure about the problem, then he will take three photographs of the affected crop parts and field condition and submit them to the online server. The scientist sitting at the back-end will take care of the issue. The solution will be uploaded onto the server and the agent will communicate that to the farmer. In the case of livestock-related issues, the agent should give a call to the local veterinary doctor from the tablet and request him to handle the case.

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:

$$InfoValue_{igt} = \beta_0 + \beta_1 eSAP_{it} + \beta_2 eSAPParticipation_{it} + \beta_3 (eSAP * eSAPParticipation)_{it} + \sum \beta_4 Z_{it} + v_t + u_g + \varepsilon_{it}$$

Where $InfoValue_{it}$ is the logarithm of choice of value of information for household i in gram panchayat (GP) g at time t, $eSAP$ is an indicator variable equal to 1 for the households in six target GPs of Gubbi and 0 for households in six control GPs, $eSAPParticipation$ is an indicator variable equal to 1 for households that denotes trial participation in 2014 and 0 for households for the year 2013, $eSAP * eSAPParticipation$ 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 errors 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' outlooks on valuing agricultural information changed in comparison to other control farmers who were not provided with the eSAP service. If eSAP had a positive effect on farmers' learning and (possibly, but not necessarily, performance on the yield outcome), we should find a positive coefficient.

For experimental design, ANCOVA is preferred over difference-in-difference estimators with a large improvement in power for noisy and less autocorrelated outcomes such as farm profits, household incomes and expenditures (McKenzie 2012). Using the Analysis of Covariance (ANCOVA) specification, we regress different outcomes on treatment status using the specification:

$$O_{ivt} = \propto + \beta_1 Treatment_{ivt} + \gamma O_{ivo} + Y_t + \theta_{gp} + \epsilon_{ivt}$$

The subscripts denote household i residing in village v in time t, O_{ivt} is the outcome of interest. $Treatment_{ivt}$ is a dichotomous variable equal to 1 if the household received the eSAP intervention. O_{ivo} is the value of the dependent variable at the baseline, Y_t is the year fixed effects, θ_{gp} is the strata fixed effects and are included to improve efficiency because the randomization is stratified by GP. The error term ϵ_{ivt} is clustered by village, the unit of randomization. We also report unadjusted p-values that control the false discovery rate alongside p-values to correct our standard errors for multiple hypothesis testing.

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Appendix 1

Questionnaire # 1: Farmer's opinion on various farming issues (March'13)

Section 1: Information available to farmers

1. What are your sources of information on farming related issues? *Please select the options that are true (√):*	[1] Rayata Samparka Kendra (RSK) [2] Krishi Vignana Kendra (KVK) [3] Other organizations (e.g. IDF) [4] Radio/ T.V./ Newspaper [5] Other farmers in your village [6] Input dealers [7] Friends & relatives living outside of your village
2. On which crops did you receive information/ advisory service in 2012 & 2013? *Please write name of the crop and the source of information for each crop.*	Crop # 1 ________________ Crop # 2 ________________ Crop # 3 ________________
3. How many visits did you make to RSK/KVK in 2012?	
4. What were the reasons for visiting RSK/ KVK? *Please select the options that are true (√):*	[1] To collect seed & fertilizer [2] To obtain training [3] To obtain information on agricultural practices
5. How many times did a RSK/ KVK extension person visit your village in 2012? If you don't know say so.	
6. Did you get educational pamphlets etc. for your crops from RSK/ KVK?	[1] Yes [2] No
7. Did you receive training on new farming technologies and mechanization from RSK/ KVK?	[1] Yes [2] No
8. Do RSK and KVK meet your informational/ advisory services needs? Indicate your level of satisfaction with their services. *Please select (√):*	[1] Not satisfied [2] Somewhat satisfied [3] Highly satisfied
9. Do you require information/ advisory services on cattle but do not get it? Is it true?	[1] Yes [2] No
10. Do you get information about prices of agricultural inputs and your products? *Mention the source of information from the list provided in question 1.*	[1] Yes [2] No
11. Do you get information about agricultural credit schemes by the government? *Mention the source of information from the list provided in question 1.*	[1] Yes [2] No

12. Do you feel that you have always easy access to the best information available about agricultural needs?	1] Yes [2] No
13. What are the major problems in order to collect information on farming practices, useful trainings and agricultural markets? *Please select (√):*	
(13-A) Do not know where to go for information	[1] Agree [2] Disagree
(13-B) Location of information centers (KVK, RSK) far away from reach	[1] Yes [2] No
(13-C) Irregularity of field visits by the KVK/RSK people	[1] Not at all [2] Somewhat [3] Very much

Section 2: Productivity issues

Crop yields (if grown by the respondent) Mention unit: quintal/kg per acre/hectare; fruits/tree	***Kharif 2012***	***Ravi 2012***
14-A. Finger Millet or, Ragi (long duration 135 days)		
14-B. Finger Millet or, Ragi (medium duration 120 days)		
14-C. Pearl Millet or, Bajra		
14-D. Sorghum or, Jowar		
14-E. Paddy		
14-F. Red gram or, Arhar or, Tur		
14-G. Bengal gram or, Chana		
14-H. Green gram or, Mung		
14-I. Ground nut or, Moong Phalli		
14-J. Areca nut or, Supari		
14-K. Coconut		
15. Are you satisfied with these yields? *Select (√):*	[1] Yes [2] No	

If you are NOT, What should be the yield in your opinion? Provide an estimate.

15-A. Finger Millet or, Ragi (long duration 135 days)		
15-B. Finger Millet or, Ragi (medium duration 120 days)		
15-C. Pearl Millet or, Bajra		
15-D. Sorghum or, Jowar		
15-E. Paddy		
15-F. Red gram or, Arhar or, Tur		
15-G. Bengal gram or, Chana		
15-H. Green gram or, Mung		
15-I. Ground nut or, Moong Phalli		
15-J. Areca nut or, Supari		
15-K. Coconut		
16. If you are NOT obtaining highest possible yields for your crops, what could be the reason(s)? In other words, What services do you require to enhance productivity? *Seven possible reasons are listed here. Please choose one of the following alternatives for each possibility:* *1 = Not at all* *2 = Somewhat* *3 = Very much* *4 = Don't know*	[1] soil testing [2] seed treatment, bed preparation [3] sowing time and methods [4] fertilizer application [5] weeding [6] pest & disease control [7] training on modern practice [8] access to credit and loans to buy modern machineries	
17. Suppose Pragathi Centers offer such crop specific agricultural informational services. Once a farmer had paid the annual subscription fee (on per acre of land basis) to the center, the farmer could avail information on best practices and agricultural markets throughout the year. Are you willing to pay a certain amount towards meeting the running cost of this service? *Please select (√):*	[1] Yes [2] No [3] Undecided	

18. If you said "YES" to question #17 then, are you willing to pay Rs. 150/acre? *Please select (√):*	[1] Yes [2] No
19. If you said "NO" to question #18 then, are you ready to pay Rs. 100/acre? *Please select (√):*	[1] Yes [2] No
20. If you said "NO" to question #19 then, are you ready to pay Rs. 50/acre? *Please select (√):*	[1] Yes [2] No

Section 3: Farmer information

21. How much land do you cultivate in 2012? (in Acres)	
22. Type of land. *Please select (√):*	[1] Owned [2] Leased
23. Which crop did contribute the most in your agricultural revenue for the year 2012?	
24. Where did you sell your produce? *Please write name of the crop and the market place for each crop.*	Crop # 1 _______________ Crop # 2 _______________ Crop # 3 _______________
25. Level of education. *Please select (√):*	[0] Illiterate [1] Primary [2] Secondary/ Higher Secondary [3] College & above

Name: -------------------------------------- Contact number: --------------------------------------

Village: -------------------------------------- Gram panchayat: -------------------------------------

Questionnaire # 2: Farmer's opinion on various farming issues (April'13)

Crop Production

1. Name 2 major crops that you grew in 2012: [A] Crop ____________ Season cultivated _____________ Yield ____________; [B] Crop ____________ Season cultivated ____________ Yield ____________
2. Do you lack *'timely, adequate, and reliable'* information which could enhance crop yield?
3. If YES, for the major crops you just mentioned, tell us at what stages of crop cycle you felt more information could be beneficial to enhance yield *(Hint: land preparation, sowing, growing period, harvesting)*.Tell us priority wise what exact information do you require *(Hint: training to implement modern technology, best management practices like fertilizer use, interculture, pest control etc)*.

Crop 1:	Crop 2:
i.	i.
ii.	ii.
iii.	iii.

Livestock production

4. Do you have animals? If YES, state the breed (= local, pure, mixed) and number of heads.

Milk cows:	Buffalo:	Goats:
Chicken:	Sheep:	Ox:

5. If you have dairy, do you get *'timely, adequate, and reliable'* information on dairy farm operations? If YES, *from whom*[12]*? And on what?*

i.	ii.
iii.	iv.

6. What is the volume of milk you are obtaining now (per cow per day)?

Breed:	Yield:	Breed:	Yield:

7. Do you think that you are getting maximum possible milk yield?
8. If NO, then on what[13] issues would you like to get information to improve dairy productivity?

i.	ii.
iii.	iv.

9. If you have poultry, what is the type of your operation? [1] Backyard/traditional   [2] Contract farming.
10. Do you get *'timely, adequate, and reliable'* information on poultry farm operations? If YES, *from whom (see note 1)? And on what?*

i.	ii.
iii.	iv.

11. What is the number of eggs you are obtaining now (per bird)?

Breed:	Yield:	Breed:	Yield:

[12] Options: Rayata Samparka Kendra, Krishi Vignana Kendra/University, NGO-s like IDF, Media, Traders. Ask farmer about these options 1 by 1 and then ask whether he can think of anything else.

[13] Options: Feed and nutrients, vaccination, disease control, heat stress, breeding.

12. Do you think that you are getting maximum possible yield in poultry?

13. If NO, then on what issues (see note 2) would you like to get information to manage your poultry to improve productivity?

i.	ii.
iii.	iv.

14. Does any veterinary person visit your poultry on regular basis for de-worming, and vaccination?

Other issues

15. Have you taken an agricultural loan in 2012?

From whom?	For what?	Was easy to get?

16. Do you get information on various agricultural loan schemes offered by the government? If YES, the source of information …

17. Are you aware of pledge loans? If YES, source of information …

18. Did you take pledge loan in 2012?

19. Is the information available, adequate regarding credit? Do you know about *where to go, how to apply (forms, documents needed), interest rate charged, other terms and conditions* in case you have to apply for a loan soon?

20. If NO, what information do you require?

i.	ii.	iii.

21. Now, we are asking some questions regarding agricultural insurance: Are you aware of various agricultural insurance schemes[14]? If YES, which ones? From where?

22. Do you have insurance cover? If YES, For crops? For livestock?

23. If YES, did you buy voluntarily or under some compulsion?

24. Is the information regarding agricultural insurance adequate? Do you know types of products, how to apply (forms and documents required and where to collect from), rate of premium charged, and other terms and conditions in case you want to buy insurance soon?

25. If NO, what information do you require?

i.	ii.	iii.

26. Do you think that in post-harvest period you lack *'timely, adequate, and reliable'* information about agricultural markets which could have helped you in selling your crop at a higher price?

27. Do you know the selling price in all nearby markets in advance before you sell your produce?

28. If YES, do you receive grade/quality specific price data?

29. Can you store your crop and wait for a better selling price? Did you store in 2012?

30. What type of weather information you would find useful? *(Hint: 1-day ahead or 2-day ahead forecast on rainfall possibility; heat waves)*. Tell us exactly what information do you require (priority wise).

i.	ii.	iii.

Name: **Village:** **Mobile:**

[14] Options: National Ag Insurance Scheme, Modified National Ag Insurance Scheme, Weather based insurance.

Questionnaire # 3: Farmers' feedback on extension & training (Jan'14)

Dear Sir,

We request you to provide feedback on this event and services provided by our agents. Please put a tick mark *(√)* to the appropriate option. Your input would help us to improve the on-going service provided to your farm. Thank you.

Farmer Name:	Village:

On training program:

1. Did you find today's training beneficial or satisfying your need for information on cultivation issues?	[1] Not satisfied [2] Somewhat satisfied [3] Highly satisfied
2. Do you want to know more about a particular topic which is covered today? If yes, please mention it.	
3. Do you know that government training centers at Kampli and Hagari organize 4 or 5 day long farmer training programs and provide free accommodation and food?	[0] No [1] Yes
4. Do you want to attend such a training program?	[0] No [1] Yes

On our service (with e-SAP tab):

5. Did you find the service provided by our agents beneficial or satisfying your need for information on cultivation issues?	[1] Not satisfied [2] Somewhat satisfied [3] Highly satisfied
6. Is our agent visiting you twice per month?	[0] No [1] Yes
7. Does he explain well what needs to be done, if you report a problem?	[0] No [1] Yes
8. Did you follow their suggestion?	[0] No [1] Yes
9. If you followed the advice, did you see any improvement in crop condition?	[0] No [1] Yes
10. Do you have any complain against the agent visiting you? If yes, what is it?	
11. Do you want to us to provide more information on your crops? If yes, please mention the topic(s).	

Questionnaire # 4: Redgram and coconut loss (Feb'14)

GP: ________________________ Village: _________________________

Name of Farmer: ___________________________ Phone: _______________

Coconut:

1. Have you faced problems with your Coconut crop?   YES/NO
2. What is the problem?

Leaves dropping/ bark seeping	Bad quality of Coconut
High incidence of pest and diseases	Other issue?
Stem bleeding	Gummy nuts

3. Have you seen this problem before?
4. What percentage of yield is lost?
5. Actual yield?
6. Expected yield?
7. Nuts lost?
8. How old are your coconut trees?   How old are the affected trees?

Follow up for solution.

9. Did you report the issue to our field agents? YES/NO
10. If yes, what advice they give you?

11. Did you follow?   YES/NO
12. Who else did you try and contact for a solution?

13. Are you aware of the state helpline? YES/NO
    a. If yes, have you contacted them? YES/NO
    b. Did they give you the needed information/any suggestions? YES/NO
    c. Did you follow the advice? YES/NO

14. Do you have an insurance policy to cover your crop? YES/NO

Redgram:

1. Have you faced problems with your Redgram crop? YES/NO
2. When did you start your crop?
3. What is the problem?

Only vegetative, no yield	Poor quality of seeds
High incidence of pest and diseases	Other issue?

4. What percentage of yield is lost?
5. Actual yield?
6. Expected yield?
7. Variety of crop?
8. When did you start sowing?
9. Where did you get the seeds from?

RSK	KVK	Traders	Other

Follow up for solution.

10. Did you report the issue to our field agents? YES/NO
11. If yes, what advice they give you?

12. Did you follow? YES/NO
13. Who else did you try and contact for a solution?

14. Are you aware of the state helpline? YES/NO
    a. If yes, have you contacted them? YES/NO
    b. Did they give you the needed information/any suggestions? YES/NO
    c. Did you follow the advice? YES/NO

15. Do you have an insurance policy to cover your crop? YES/NO

Name of the Interviewer: __________________________Date: ___________________

Questionnaire # 5: Helpline Survey (Feb-Mar'14)

Farmer's Phone Number: ____________________ **No. given to Farmer: ________________**
Farmer's age: ____________________
Male/Female: ____________________
Education of famer calling: ____________________
How many acres of Red gram did you plan to cultivate in the next season before calling the helpline?: ____________________

Please complete the following survey, circling answers under each section heading. The answers are broken down in order to get as much detail as possible. For example, if for ***Section 1. Calling the Number*** and the farmer answers **a.*No*** ask for a response from either **i., ii., iii.,…** and further ask for a response from **1.,2.,3…..**

Section 1. Calling the number

1) Did you try to call the number? Yes/No
If yes go to b. below
   a. If no, why you did not call the number?
      i. Not interested in the crop any more

         why?

         1. Is it because of this disease
         2. Not profitable?
         3. Any other. Please specify _______________________
      ii. Will try later
         1. When are you planning to try?_____________________
      iii. Do not expect to get any useful information
         1. Is your perception based on your own past experience?
         2. Neighbour/friend/relatives' experience?
         3. Perception based on general feeling?
         4. Other. Please specify _______________________
      iv. Pastexperience has not been good
         1. Had called earlier on this number but no proper answer was given? How many times you have tried before?_____________________
         2. Had you called similar number but no proper answer?
         3. Government offices do not give proper answer
         4. There is no help a farmer can get on such information.
         5. Other. Please specify _______________________
      v. Any other? Please specify _______________________
   b. Yes I called the number
      i. Was the call answered? [Y/N]
      If YES,

1) Provided proper answer
2) Answered but could not understand
3) Answered but not properly
4) Notable to answer
5) Suggested another contact

ii. If the call was answered are you satisfied with the response?
   1. Completely satisfied
   2. Somewhat satisfied
   3. Not satisfied

iii. Suggested another contact
   1. What is the contact information given? ________________________
   2. Was it clear who this contact is? [Y/N]
   3. Did you try to contact? (Y/N)

iv. Not able to answer
   1. Did they say ‘do not know’? [Y/N]
   2. Did they say’ they will come back to you later’?[Y/N]
   3. Asked you to call later? (Y/N)
   4. Did they give you any timing for call-back? (Y/N)
      If Y then when? _____________________________
   5. Any other. Please specify _______________________

v. Did not answer the call
   1. How many times the number was tried?________
   2. Planning to try again? (Y/N)

vi. Answered but could not understand
   1. Did not understand the language
   2. Did not understand the explanation
   3. Other. Please specify _______________________

vii. Proper solution was not given
   1. The solution was tried earlier but did not work
   2. Other farmers told me that the solution will not work
   3. Other. Please specify _______________________

viii. Any Other. Please specify _______________________

<u>Section 2. Consequence or actions of calling the number</u>

c. So after you called the helpline, will you follow the advice given?

i. Yes I will follow the advice given.
   1. Follow everything they suggested
   2. Follow their advice as much as I could/afford to
   3. Do as much as I could

ii. No,I will not follow the advice given.
   1. Lack of money

2. No point in following
3. Will try later
4. Too much work/not worth the effort
5. Any other. Please specify ______________________

iii. Did the helpline tell you where you could buy the necessary pesticides/equipment?
    1. Yes/No

iv. Did they tell you a rough price for these materials?
    i. Yes
    ii. No

v. Following your call to the helpline, will this change the acreage of redgram you will grow next season?
    1. I will grow less redgram than planned before
    2. I will grow the same amount of redgram as planned before
    3. I will grow more redgram than planned before
    4. Have you decided the acerage that you will grow next season?_________

<u>Section 3. Opinion of the usefulness and trustworthiness of the information</u>

d. Do you feel that you can trust this advice
    i. No
        1. Why Not?
            1. Government have not been much help before
            2. Have heard different advice from others
            3. No one visited my farm, so they don't really know the damage
            4. Other
        2. What could be done to make you trust the information more?
            1. Suggest where I can go for another opinion
            2. provided access to local agencies such as KVK/RSK to ask for information in person
            3. Pamphlets sent out or able for me to collect to look at the information myself
            4. Other. Please specify ______________________
    ii. Yes I trust the advice given to me.
        1. Completely trust
        2. Partially trust
        3. Somewhat trust
        4. Do not trust

Section 4. Future use of the phone lines

e. – Do you think you will use this helpline in the future
   i. No
   ii. Yes
f. Would you recommend the use of these helplines to other farmers in the future?
   i. No
   ii. Yes

Section 5. Remedial measure or thoughts on how to improve the information delivery system

g. What ways could the helpline be improved to make the service better?
   1. Provide better information
   2. Suggest someone local who could offer advice (KVK, RSK)
   3. Helplines to actually answer the calls
   4. Phone line open at more times (longer opening hours)
   5. Phone lines open at the weekends
   6. Available in local language
   7. Any other. Please specify ____________________
h. What other information would you want to receive from a helpline?
   1. Information on other crops
   2. Information on different varieties
   3. Information on finance schemes like loans
   4. Information on subsidy programmes
   5. Information on pesticides/seeds/fertilisers
   6. Information on proper cultivation practices
   7. Weather information
   8. Any other. Please specify ____________________
   Other

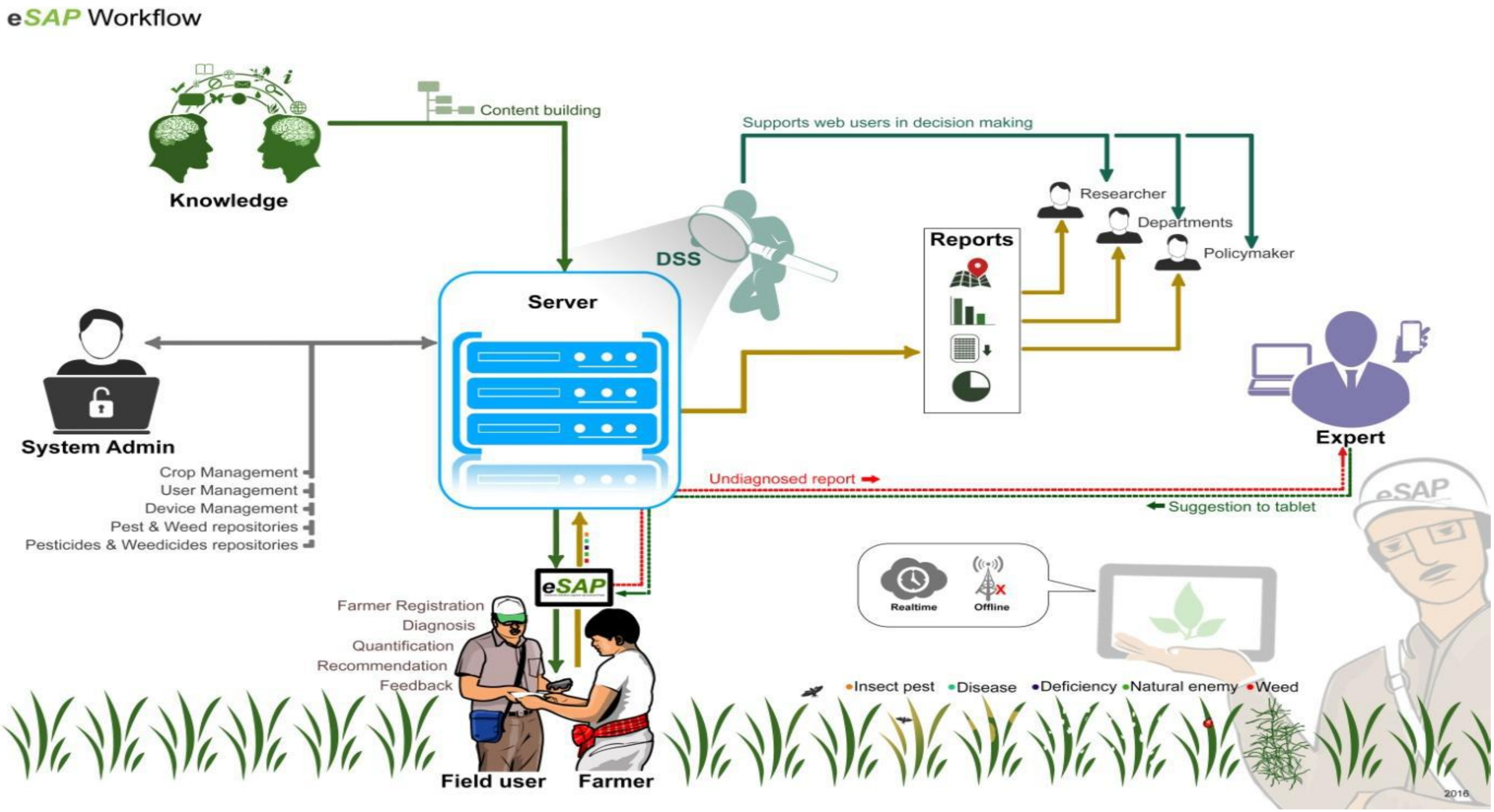

Figure 1: e-SAP workflow

Figure 2: Field captured images of paddy crop

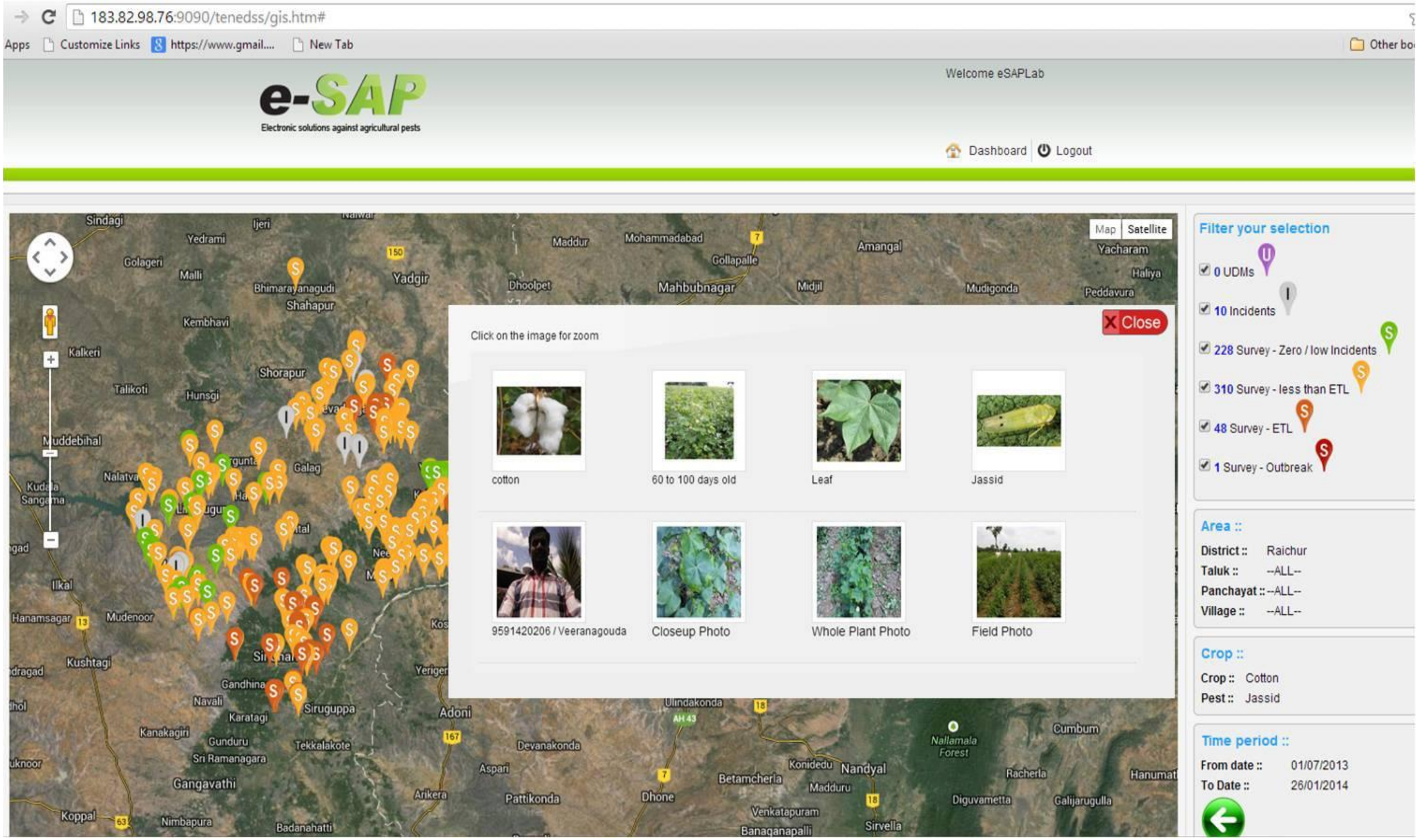

Figure 3: Expert virtual laboratory for diagnostics and solutions