Impact of Mobile Telephone on the Quality and Speed of Agricultural Extension Services Delivery: Evidence from the Rural e-services Project in India

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Summary

This study examines the impact of a mobile phone technology enhanced services on agricultural extension services delivery system in India. An impact analysis is carried out based on randomised survey data taking into account of potential systematic selection bias through double difference techniques and reflexive comparisons. Findings from the research show that the amount and quality of the services and the speed of services delivery have been improved significantly as a result of the intervention. Evidence from the evaluation suggests that disadvantaged farmers benefit more from this intervention than those who are better off.

Key words: Mobile phone technology, agricultural extension services, impact analysis, India

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I. INTRODUCTION

Mobile phone penetration has been growing rapidly even in the remote rural areas. The unprecedented speed of adoption of mobile phone technology has raised the general expectations about its potential contributions to spread of innovative farming technology on time with adequate speed. The question is whether mobile phone technology can add speed and quality of the agricultural extension services delivery? To our knowledge, so far there is no large survey data-based evidence on the impact of ICT on agricultural extension services delivery in remote areas probably due to the lack of reliable data on outcome variables, as well as variations across extension and non-extension communities and between users and non-users in observable and unobservable factors (Aker, 2010). The pioneering studies of Jensen (2007) and Aker (2008) focus on the impact of mobile phone technology on price services provision for fishers and in the grain market.

This paper attempts to assess the impact of mobile phone technology on rural services delivery based on an evaluation of an UK Engineering and Physical Science Research Council (EPSRC) funded 'Knowledge Help Extension Technology Initiative' (KHETI) project in India. In particular, this paper investigates to what extent such technology diffuses new practices and can help farmers gain agricultural knowledge, and whether it has been effective in delivering quality and speedy extension services as expected. The assessment uses a purposely designed randomised survey data comprising treatment group as well as a control group before and after the intervention (experimental design). The paper contributes to the literature by adding empirical evidence on the impact of mobile phone technology on agricultural extension services delivery. It also demonstrates the effect of such ICT-assisted new experience on farmers' attitude and aspiration towards future new technology adoption.

The remainder of this paper is organized as follows. Section II briefly discusses literature on extension services delivery and evaluation. Background of the study including the context in India and the KHETI project are discussed in section III. Methodology including evaluation design, sampling strategy and data collection approach as well as impact indicators and analytical framework is explained in section IV. Section V presents the results. Section VI concludes.

II. LITERATURE REVIEW

Agricultural extension services include transferring knowledge to farmers, advising and educating farmers in their decision making, enabling farmers to clarify their own goals and possibilities, and stimulating desirable agricultural developments. Traditional public-sector extension services use a variety of extension programmes to overcome barriers to technological adoption without much success (Anderson and Feder 2004, Anandajayasekeram et al. 2008, Aker 2010). Historically, agricultural service delivery in developing countries started with production-oriented limited extension services for export crops. The attention was diverted in the fifties to food production and improved farming techniques (Anandajayasekeram et al. 2008). In the 1960s US-led 'technology transfer model' employed a large number of extension agents to provide extension services. Since then, with the rise in the demand for agricultural services, many variants of approaches, models and methods have been evolved to connect researchers, extension agents, producers and consumers (Leonard 1977; Garforth 1982; Feder, Just and Zilberman 1986; Axinn 1988; Anderson and Feder 2004). The World Bank sponsored Training and Visit (T&V) extension model, Farmers Field Schools (FFS) and fee-for-services are the most common approaches. In the T&V and FFS systems, extension workers passed information to selected contact farmers who shared information with other farmers (Anderson and Feder 2004). It is widely accepted that extension services are an important element in farming but poor and marginalized farmers in remote villages remain beyond the reach of appropriate services.

ICT allows efficient and transparent storage, processing and communication of information and that entrepreneurial innovation in this field may affect economic and social change (Kaushik and Singh, 2004). Growth in ICT investment is found to be positively associated with growth in both GDP and productivity in Asia-Pacific countries for the period 1984-1990 (Kraemer and Dedrick, 1994).

It is increasingly recognised that ICT is necessary for accessing required information and knowledge (Richardson 1997; Chapman et al. 2004; Anandajayasekeram et al. 2008; Mcnamara 2009; Aker 2010). ICT kiosks, ICT-equipped intermediary organisations and mobile phones are expected to play an important role in strengthening the more complex and time-urgent pathways of information and knowledge-sharing on which agricultural innovations depend. A workshop organised by the World Bank found ICT was underutilised in extension services delivery and hence the need to support policy environments and programmes that use ICTs (Alex et al. 2004). Moreover, Heeks and Molla (2009) found in their ICT evaluation compendium that ICT is not fully utilized in agriculture. Scaling up of delivery still remains at experimental stage. Although farmers have the real need to access to market information, land records and services, accounting and farm management information, management of pests and diseases, rural development programmes and ICT could help accessing these services, ICT projects dealing such services are extremely limited (Meera et al., 2004). Poor, marginalised and illiterate farmers and females are excluded, and marginal areas are excluded.

Of course, ICT is not always found to deliver its promise as expected. Chowdhury (2006) found a negative effect of ICT investment on the labour productivity of East African small and medium-size enterprises, which is likely due to the low cost of labour relative to capital in East Africa which prevents substitutability being a profit maximizing approach. Moreover, a lack of knowledge of best practices in IT usage as well as IT-related skill deficiencies in the workforce will also constrain the benefits from ICT, as argued by Kaushik and Singh (2004) based on case studies of two projects in North India. The digital divide is not merely a problem of access to ICT, it is part of a larger developmental problem in which vast sections of the world's population are deprived of the capabilities necessary to use ICTs, acquire information and convert it into useful knowledge. Balanced growth is needed and deep structural problems must be solved to make ICT-induced development more inclusive (Parayil, 2005).

Mobile phone technology has been spread rapidly in the rural areas of the developing countries in recent years. It has the advantage over other ICT tools in terms of its appropriateness for the under-developed local conditions. Other than mobile phones, other ICT tools suffers from the problem of feasibility for the poor in geographically disadvantaged areas because of lack of enabling environments such as infrastructure and capital. Internet enhanced technologies are not appropriate in the areas lacking electricity and network infrastructure. On the contrary, mobile phone technology has much less requirement on the infrastructure and hence wider applicability especially in mountainous areas. Mobile phones enable both audio and video functions which can meet most of the basic needs of the poor. It also has greater affordability for the farmers than internet. In many developing countries more than 80% population have access to mobile phones. Jensen (2007) demonstrated that the ICT helped fishers along the coastline in Kerala, India learn about prices at different locations and decide where to sell their products profitably. As a result, price volatility and variation dropped; producer prices rose and at the same time consumer prices dropped. Aker (2008) studied the impact of the mobile phone rollout on grain markets in Niger and showed that mobile phone service has reduced grain price dispersion across markets by a minimum of 6.4 percent and reduced intra-annual price variation by 10 percent.

III. Background

Agricultural extension services delivery in India

India has been experiencing major changes in agricultural extension system since the 1990s (Rivera, Qamar, and van Crowder 2001; Birner and Anderson 2007; Anderson 2007, Raabe 2008). The reform included both demand and supply side measures. The demand side measures were the decentralization of extension service provision to the local level, the adoption of pluralistic modes of extension service provision and financing, and the use of participatory extension approaches. The supply side measures included civil service and public expenditure reform, training and capacity building, public-private partnership and utilisation of ICT for government services. Examples of initiatives are the World Bank funded Diversified Agricultural Support Project (DASP) and the National Agricultural Technology Project (NATP), Danida and IFAD funded gender focussed projects and the private sector e-Choupal initiative (Rabbe 2008). The public sector programmes are constrained by many factors including lack of transportation and communication and poor skills of service providers. Nevertheless, public sector reform has been continuing, for example, the "Support to State Extension Programmes for Extension Reforms" which aimed to help the states revitalize their extension systems for the agriculture sector. However, given the limited capacity of public extension services, it is not possible to reach the smallholder in remote areas without speedy technology that can easily reach the remote areas.

Private sector initiatives in the area of agricultural extension services delivery are extremely limited. Widely discussed initiative is e-Choupal, an ICT enhanced initiative of the Indian Tobacco Company. The technologies depend on computers, internet and land line connections. The problems also include slow and disruptive internet connectivity, poorly maintained land lines, the unreliability of electricity supply and power backup systems and operational constraints from the inadequate maintenance and support of the equipment (Annamalai and Rao 2003). There are also some initiatives involved the establishment of information kiosks and information shops. Farmers are provided with information on crop technology and farmers' rights, loans, and the availability of grants (Singh 2006). However, the disadvantaged section of the population was still out of reach.

The KHETI project

The Agricultural Information Flow System titled 'Knowledge Help Extension Technology Initiative' (KHETI) was funded by the EPSRC and carried out by an interdisciplinary team including Oxford University, Sheffield Hallum University, the Overseas Development Institute and Saral Services (a NGO in India). The primary objective of KHETI was to speed-up the communications amongst various stakeholders involved in the extension services delivery system. Stakeholders include agricultural scientists, agriculture communication specialists, communities and farmers. A primary component of the project was helping a NGO known as 'Sironj Crops Producers Company Limited' (SCPCL) with the KHETI. SCPCL is an association of poor and marginalised farmers in Madhya Pradesh. SCPCL aims to provide its members with information on agricultural techniques, market prices, and to enable them getting access to better and quality services. There were around 40 villages under each SCPCL office having only one agricultural expert. Huge travelling time and costs were involved and realistically it was not possible to satisfy the needs of all farmers. Farmers cannot travel in the peak seasons without affecting farming activities negatively. Farmers have a basic need for a system that can enhance the flow of the timely information at the door-step. The purpose of the KHETI project was to introduce an ICT enhanced solution to these problems.

Technologies used in KHETI are special mobile phones that are carried by '*Munnas*' who are the assistants to agriculture specialists travelling in the villages. The mobile phones are used to create Short Dialogue Strips (SDSs), which are audio visual creations on the local agriculture problem, issues and knowledge. An SDS includes a maximum of six images and two minutes of audio recording. In this system specialists do not need to visit farmers to know problem and answer queries and farmers do not need to physically visit specialists to report problems and get solutions. The *Munnas* can pass on any issue on crop and farming to an agricultural scientist on behalf of farmers and convey the solution to the farmers using the special mobile phones. Thus *Munnas* help farmers and agriculture experts to exchange queries and solutions through SDSs. This technology was designed and developed through participative design and agile programming method. Prior to designing the features a series of meetings and participatory exercises took place with the farmers to assess the needs. The project was located in Sironj Block (sub-district) of Vidisha district of Madhya Pradesh (MP) in Central India. Most of the people of the district are farmers. Main crops in Sironj are wheat, gram and maize in winters and soybean in rains. Though MP has the largest tribal population and particularly scheduled tribes, non-tribal population is concentrated in the central part of MP where Sironj is located. The services were free to the farmers.

IV. METHODOLOGY

(1) Measurement of impact

In this study we intend to measure the change in extension service delivery in the project area in relation to "what would have happened to extension services delivery" in absence of the newly introduced mobile phone based technology. The group, which contains the effect of an intervention, is called the 'treatment' group and the group, which is similar to treatment group but has not been exposed to the programme intervention, is known as the 'control' group or 'comparison' group. The purpose of the control group is to provide an estimate of what would have happened in absence of the intervention, this is called 'counterfactual'. The counterfactual cannot be directly observed but must be approximated with references to a control group. Whether the estimated impact is 'valid and generalizable' depends on the evaluation design, which takes care of identifying the control and treatment groups as closely as possible. Once the groups are closely identified and the indicators are chosen, the difference in indicator variable between the groups would capture the robust impact of an intervention.

Mathematically, under the perfectly controlled experiment or randomisation, typical average impact could be expressed as follows (Rubin 1974, Ravallion 2008):

$$\bar{I} = \frac{1}{n}\sum_{i=1}^{n}(O_i^T - O_i^C) \qquad (1)$$

where I is “impact”, also known as “causal effect” or “gain” or average treatment effect (ATE), O is the value of the interpretable impact indicator, T and C represent treatment group and control (comparison)[1] group respectively, i represents the sample units (in this study it represents the participants of KHETI project and non-participant farmers or farm household) and n is the sample size. In randomized experiment the average I is an unbiased estimator of the true impact, which is unknown because one of O^T and O^C remains unknown at the time of evaluation being done (Dehjia and Wahba 2002). This is known as missing value problem because O^T and O^C cannot happen simultaneously.

There have been substantial discussions on the evaluation designs and methods to find unbiased estimates of the unknown outcomes and hence impact (Baker 2000, Ravallion 2008). The main designs for impact evaluation include randomization or experimental method, nonexperimental and quasi-experimental designs. Evaluation methods include reflexive comparisons, double difference or difference-in-differences method, and instrumental variables method. *Randomization* or experimental design selects the treatment and control groups randomly within some well-defined set of people. This implies that there should be no difference (in expectation) between the two groups besides the fact that the treatment group had access to the intervention programme. There can still be differences

[1] In the impact evaluation literature, the term ‘comparison group’ is used in case of non-experimental and quasi-experimental designs and ‘treatment group’ is used in experimental or randomised designs.

due to sampling error; the larger the size of the treatment and control samples the less the error. *Reflexive comparison is a method of impact measurement*, in which a baseline survey of participants is done before the intervention and a follow-up survey is done after. This means that the data are compared to the same individuals after project implementation (Jalan and Ravllion 2003). The baseline is regarded as the control group and follow-ups as the treatment groups, and impact is measured by the change in outcome indicators between baseline and follow-ups (Kerr *et al*. 2002). This is a single difference method of impact evaluation design. *Double difference or difference-in-differences (DID)* methods compare a treatment and control group (first difference) before and after an intervention (second difference). In other words, there are both control and treatment groups during the baseline and follow-ups. Thus the DID method is the extended version of the reflexive comparison and can be extended to higher order differences.

(2) Evaluation design

KHETI was an action research project and so ex-post evaluation was considered an important component and the design was chosen carefully to identify the actual impacts of the intervention. Two surveys were carried out in the Sironj Block; the first in July 2008 is the baseline, before the intervention which was started in August 2008; and the next follow-up survey was carried out in March 2009, approximately 8 months time from intervention. Thus the surveys produced both longitudinal and cross-section data sets but the gap between the two surveys is too short to evaluate longer term impact, rather is possible to compare immediate outcomes of KHETI project.

Both surveys (baseline and after intervention) include a control group along with the treated, and used structured questionnaire to interview selected farmers. The block has altogether 225 villages and there were a total of 698 active shareholders of SCPCL in 30 of the villages; all of them were interviewed. They are the beneficiaries of KHETI. The control group was chosen from non-SCPCL villages. The initial thought was to include a matching group of 698 non-member farmers. Due to multifarious constraints such as limited time, unfavourable climate and limited resources 507 non-member farmers from 26 non-SCPCL villages were interviewed. This sample was selected as follows. Out of 225 villages 150 have no interventions from SCPCL or any other NGO. From the list of these 150 non-SCPCL villages, 26 villages were selected randomly, which is around 18% of the non-SCPCL villages in the block. From each non-SCPCL village, 20 to 25 farmers (ie. households) were chosen for interview. In percentage term 20 to 100% of the families from the selected villages were included in the non-member sample. The villages of Sironj are small with a maximum number of 100 families in some of the villages. Some of the villages are very small. Either 'all households' from the small villages were included for interview (100%), or most of the households were chosen; from relatively larger villages households were chosen randomly. The non-member farmers are selected such that they are not beyond the ranges of age, own land and per capita income of the members of SCPCL, and so groups are somewhat matching in terms of major characteristics but numbers are different: 698 member farmers and 507 non-member farmers.

The study used a double difference design; both treated and control groups were interviewed before the intervention with a follow-up nearly one year after. Due to randomisation, the difference between treated and non-treated groups is expected to be unbiased estimate of true impact. However, as in other social experiments, it is not possible to control for all characteristics that may systematically influence outcome variables. So it is necessary to check the robustness of impact.

(3) Data description

The survey uses structured questionnaires collected by trained local survey assistants via personal interviews. English version of the questionnaire was translated into local language. Socioeconomic profiles of the sample are presented in Table 1. Apparently, sample appears to be biased towards male. This reflects Indian farming context; the occupation is usually dominated by males. The male members are primarily responsible for farming and so they are the shareholders of SCPCL, though they are assisted by their female counterparts. Most of the female members were located in a particular village because of the ethnic nature of the community in that village with female dominance. Mean age of sample producers is around 39 years with a median of 35 years. About 50% of the farmers are illiterate. Majority belong to backward caste. With respect to age, education and annual income, the difference between non-member and member/shareholder categories is negligible. There are variations in terms of gender, marital status and caste. The groups are statistically the same in terms of own land though members have significantly higher access to encroached and leased land and their human capital for agriculture is significantly higher. Average land ownership of the sample farmers is 3.09 acres, lower than the MP average. The treated farmers owned from 0 to 35 acres of land and the non-treated farmers owned from 0 to 32 acres. Some landless families are included in both groups. Primary occupation of more than 97% of them is agriculture, others are mainly labourers. However, the average income of both groups of farmers is much higher than the median indicating inclusion of a few farmers in the sample with excessively higher income than the average.

[INSERT Table 1 HERE]

(4) Impact indicators

Both quantitative and qualitative indicators can be used to measure the direct and indirect impact of the mobile phone technology on the extension services delivery and on farmers' knowledge, awareness and attitude to new technology. More common quantitative measure could be productivity. Adoption rate of a particular technology due to a specific extension approach like the farmers field school is also a widely used indicator. Other indicators such as farmer's knowledge, attitude, awareness and contact intensity are also used to measure the impact. Increased knowledge and awareness are generally considered prerequisites to the adoption of new practices and technologies.

Changes in knowledge, attitudes, skills and aspirations lead to changes in practices, which in turn cause the desired change in production and therefore income of the farmers. The variables like knowledge, awareness, and aspirations have no rigid definitions and are difficult to measure but not impossible. For example, Erbaugh et al. (2001) measured farmer's knowledge about integrated pest management (IPM) using an index constructed from rated attributes. There could be more indicators (van den Berg and Jiggins, 2007). For example, the FFS curricula often have been designed to enhance farmers' educational, social, and political capabilities. In our case, ICT technology was designed such that member farmers of SCPCL can get a broad range of information on time, with adequate speed and quality. We would expect immediate gains from the initiative directly on the quantity, speed and quality of extension services, and indirectly on farmers' knowledge, awareness, and attitude towards using extension services as well as farm practices and technical know-how. Farmers would be expected to use timely information on seed, fertilizer, pesticides and prices to improve their welfare.

The surveys included some questions related to direct impact such as speed, quality and quantity. In addition to descriptive analysis, we constructed a quality index (QI) as an outcome indicator to measure impact using equation (2) and a quality related question, details of which are given in Appendix 1. The farmers were asked to score the quality of the services of all providers on a scale of 1 being the worst quality and 5 being very good quality. There were eight sources other than *Munnas*. Farmers used these other sources before the intervention. The government services appeared the worst and the *Munnas* are the best of quality. As for an individual source, the scores ranged from 1 to 5. The sum of the scores from 8 sources before the intervention ranged from 8 to 40. We standardized the scores of both before and after situations into positive numbers up to a maximum of 1. This is done using the method as in equation (2).

$$O_i = \frac{\sum_{j=1}^{J} O_j}{S} \qquad (2)$$

Here, O is outcome in general (here it is QI), i represents sampling units (member and non-member farmers), j=1, ..., J. J is the total of component attributes , S is the maximum limit of scores a farmer can have. Qi was measured for both treatment group and control group separately. So the values of QI ranged from 0 (indicates lowest quality) to 1 (highest qualitye).

(5) Empirical estimation strategy

In the double difference framework, the impact in equation (1) can be rewritten as:

$$\bar{I} = \frac{1}{n}\sum_{i=1}^{n}[(O_{i1}^{T} - O_{i0}^{C1}) - (O_{i1}^{C2} - O_{i0}^{C2})] \qquad (3)$$

Where, C1 is the treated group before the intervention, C2 is the non-treated control group, the subscript '0' denotes baseline and the other subscript '1' stands for after intervention. We would expect equation (3) (equation 2 in case of reflexive comparison) to produce unbiased impact due to randomisation, but due to the nature of social experiment we do not rule out the possibility of systematic differences between the groups and so examined the robustness of the impact using regression analysis as follows:

$$O_i = \alpha + \beta_k \sum_{k=1}^{K} X_{ik} + \gamma ICT_i + \partial V + u_i \qquad (4)$$

Where O_i is outcome variable of interest, such as farmers' agricultural knowledge, adoption of the agricultural technology, speed of delivery of extension services, quantity/quality of services, yields or welfare etc.; X_i is a vector of farmer specific characteristics variables; V_i is a vector of village specific factors, u_i is random error with usual properties. ICT_{it} is an indicator variable for ICT-enhanced agricultural extension services. Because KHETI services targeted all member farmers of SCPCL but not non-member farmers, ICT equals 1 for SCPCL members in t=1 (post-intervention) and 0 for the rest[i]. The farmer and village specific characteristics variables are chosen based on the common practice of rigorous impact studies as well as parsimony. Highly insignificant variables were dropped from the model, assuming that such variables will not cause omitted variable problem. Definition and descriptive statistics of the variables are reported in Appendix 2.

V. RESULTS

Here we use reflexive comparison, because KHETI was meant for members and so some impact questions in the final survey are applicable only to them. A descriptive analysis is presented in Table 2. Majority of the farmers rated the new technology more useful, faster and of better quality. Farmers were using more services than they used before the project. More than 75% of the farmers view mobile phone assisted services useful, more than 86% view KHETI services faster and 13% view it much faster than the other services that farmers had prior to the introduction of this innovation. Around 96% of the farmers were using more agricultural advice after they were exposed to innovation. About 88% of the farmers view the extension services are of better quality compared to the services they received before. The average estimated quality index (QI) increased from 0.57 before the intervention to 0.92 after the intervention. Thus the treated farmers judged the new service far better than the existing services; the gain was 61% higher than the previous services. In general, it appears that the impact of information technology was prominent in quality of extension services. Of course, the possibility of overstatement of the quality of the ICT-enhanced services cannot be ruled out. The services were initially delivered free of cost. Farmers might have expected continuation of the service similarly if they could present the benefit more powerfully. However, even if we assume some degrees of exaggeration, still the new method of service delivery would be a significantly higher quality-enhanced technique.

[INSERT Table 2 HERE]

We further assessed the impact on services quality while controlling for some farmer- and village-specific characteristics. Table 3 reveals the multiple regression results. Due to the nature of the dependant variable (QI), which ranges from 0 to 1, we use Tobit model for estimation, because OLS may not produce consistent estimate for censored dependent variable (Cameron and Trivedi 2009). Nevertheless, we report both Tobit and OLS estimation results for robustness check. Regression specification error test (RESET) suggests that there is no significant error in model specification[ii]. White heteroskedasticity-corrected estimates are employed since a significant heteroskedasticity was detected (Breusch-Pagan Chi_2=33.66, prob>Chi_2=0.00). The estimated effect of ICT on the quality of services is positive and statistically significant at 1% level. The results are consistent and robust across different models and specifications. The magnitude of the estimated coefficient of the ICT variable is 0.42 in the Tobit model, suggesting that the quality of services is 0.42 units higher due to the use of mobile phone technology. Given the mean QI of the treatment group before intervention at 0.57, this suggests an increase of 74% in overall quality after the introduction of KHETI intervention. The OLS estimate was smaller but still the QI due to ICT was 0.35 units higher than the services without ICT, suggesting a 61% increase after the intervention.

Other significant factors are age of farmers, land rental, irrigation and agricultural assets. Land rental and access to irrigation facilities affect quality of the extension services negatively. Those renting might have put less effort to obtain quality extension input due to disincentives arising from sharing or leasing arrangements. Those renting out are not directly involved in cultivation and so might get less attention from extension agents. Landlords may be relatively more influential to obtain existing pre-intervention extension services. Farmers with irrigation facilities are expected to be more aware of improved practices and might have access to relatively better extension services before the introduction of ICT enhanced services. Farmers who own agriculture assets appear to have received higher quality service partly because they made more efforts in seeking extension services that are relevant and useful to them. Marital status is marginally significantly associated with the quality of the services the farmers receive suggesting social factors like marital status may influence service delivery. This may be more relevant for adult women in India. Often unmarried/single/widow are discriminated due to social attitude. Extension people may find it easier to communicate with a married person than a single.

Village level characteristics also appear to be associated with services quality farmers received. Farmers in villages with better infrastructure such as access to buses and electricity have reported higher services quality than farmers in villages without access to these infrastructures. However, farmers is richer villages appear to be slightly less happy with the changes in services quality than farmers in poorer villages although the magnitude of the estimated coefficient is almost negligible. This may also be affected by some psychological factors, for example, farmers in richer villages have a higher expectation and standard for the services they receive.

[INSERT Table 3 HERE]

Quality is often categorised into technical and functional. In regard to mobile phone technology, technical quality may refer to the network coverage, bandwidth, network congestion, voice quality, data transfer delay, network security, data loss rate, software reliability, reliability of data transfer and efficient service restoration (Siau and Shen 2003, Wee and Guitierrez 2005). Functional quality refers to the reliability, responsiveness, access, communication, security, accuracy and specificity of information, ease of use, affordability, availability and access. Quality can also be reflected in the frequency farmers demand queries to the Munnas and how promptly they are answered. Farmers are hence asked about this information in the evaluation. Table 4 reports the comparisons of the frequency of queries raised by farmers and the speed of answers they receive before and after the KHETI intervention. We note a considerable increase in the demand for services. As baseline survey identified, more than 89% of the member farmers had no queries to SCPCL. All of them however, according to the final survey, had queries to get answered. Some farmers (6.5%) were even asking for information many times in a week supporting farmers' augmented thirst for agricultural knowledge, practices and information. The mobile technology also helped to deliver the services quickly. In their responses to the question 'how long does it take SCPCL/*Munnas* to answer your queries?', only 5% of members reported a quick response during the initial survey before intervention, and this proportion was increased to 37% in the final post-intervention survey. Answering the queries within a day increased from 2% to 31%. This indicates a massive improvement in the communication between farmers and SCPCL.

[INSERT Table 4 HERE]

VI. CONCLUSIONS

This study examines the impact of an innovative mobile phone technology-assisted agricultural service delivery system (KHETI) for poor and marginalised farmers in Madhya Pradesh of India. The project provides speedy communication of audio-visual dialogues between farmers and agriculture experts through local youths called *Munnas* and special mobile phone technology. It aims to solve the problem in reaching all the members of SCPCL with timely extension services. This evaluation of KHETI system is based on randomized survey data collected through structured questionnaires before the intervention and approximately 8 months after. Immediate impacts on speed, quality and usage of the services are assessed. Particularly, Quality Index (QI) was used to measure the impact of innovarive mobile phone technology.

Our evidence demonstrates that farmers assessed the quality of the services around 0.42 units (74%) higher than what was available before the ICT enhanced services. More than 75% of the farmers view mobile phone assisted services useful, more than 86% view *Munna* services faster than the agricultural services that were accessible prior to the introduction of this innovation. More than 96% of the farmers were using more agricultural advice after they were exposed to innovation.

Moreover, the experience of using this mobile phone technology assisted extension services has made farmers feel more at ease with new technology and adapting to new things for life in the future. Admittedly, the longevity of farmers' attitude towards e-services is subject to continued examination, especially with ongoing evolution and revolution. Historically, any successful new technology has always created its own set of applications that do not exist when it was conceived and similarly when mobile phone technology was invented, poor farmers did not know that they could use them for learning new agricultural knowledge that they require to improve their way of life. The experience of using KHETI to certain extent opened farmers' mind regarding the relevance of modern information and communication technologies to their production activities and their life.

Another crucial finding from this research is that our evidence indicates that the disadvantaged farmers and poorer communities gained more from this ICT-assisted intervention than those who are better off. There may be some misunderstanding that modern technologies such as ICT benefit only the rich and the educated, but do not really work for the bottom of the pyramid. The developmental goal of technological advancement may not reach the community that are most disadvantaged. Evidence from the KHETI project suggests that ICT-assisted intervention can generate significant developmental effects for the poor. This achievement of the project may be to certain extent due to the choice of an appropriate technology, the mobile phone technology, instead of more advance networked internet system in the poorest part of India. This is a useful lesson that we can learn from the KHETI experience for future ICT or wider technology for development projects.

One of the fertile grounds for future research is to identify the improvement in farm practices, efficiency and competitiveness due to *Munna* services and so direct the innovation towards supporting efficient and competitive farm practices by the small and marginalised farmers. Moreover, it is important to identify which factors may influence the strength of the impact of ICT on the final outcome of intervention such as welfare. Appropriate policy would then target these factors to ensure better access of the disadvantaged groups to resources. The maximum success from an intervention like the ICT enhanced extension services delivery thus remains not only on the better method but also on the capacity of the target group to use information.

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Table 1. Socioeconomic profiles of the sample farmers/producers

Characteristics		Non-member (N=507)	Member (N=698)	Total (N=1205)
Gender %	Female***	3.2	18.3	12.0
	Male***	96.8	81.7	88.0
	Total	100.0	100.0	100.0
Age (years)	Mean	39.4	38.4	38.8
Education %	Illiterate	52.3	48.4	50.0
	Primary**	34.1	40.3	37.7
	Middle	8.7	7.9	8.2
	High School*	4.1	2.3	3.1
	Intermediate & Above	0.8	1.1	1.0
	Total	100.0	100.0	100.0
Marital status (N)	Divorced	1	1	2
	Married***	490	645	1135
	Unmarried***	4	25	29
	Widow	8	18	26
	Widower	4	9	13
Caste category (%)	General**	13.4	9.3	11.0
	Other Backward Caste	54.0	52.1	52.9
	Scheduled Caste***	23.9	36.7	31.3
	Scheduled Tribe***	8.7	1.9	4.7
	Total	100.0	100.0	100.0
Adult members (persons)	Per family***	2.15	2.35	2.26
Children (persons)	Per family*	2.56	2.41	2.47
Own land (acres)	Per family	3.17	3.03	3.09
Encroached land (acres)	Per family***	0.17	0.62	0.43
Leased in land (acres)	Per family***	0.04	0.51	0.31
Leased out land (acres)	Per family*	0.06	0.11	0.09
Persons available for agriculture	Per family ***	2.1	2.4	2.3
Primary occupation (%)	Agriculture***	95.3	98.9	97.3
	Labourer ***	4.1	0.7	2.2
	Other	0.6	0.4	0.5
Annual per capita income (Rs.)	Per family*	3492	4528	4277

Source: Questionnaire survey 2008.

Rs. is Indian currency Rupees (1 US$= Rs. 48.8 during the survey in November 2008);

T-test results of equal means between the member and non-member groups are reported as *** Significant at 1%, ** Significant at 5%, * Significant at 10% level.

Table 2. Impact of ICT intervention: usefulness, effectiveness and changes in quality and attitude

		Freq.	Percent
How useful *Munna* Services are	Very useful	118	16.9
	Useful	530	75.9
	Medium	48	6.9
	No use	2	0.3
	Total	698	100.0
Speed of services compared to before	Faster	604	86.5
	Much faster	90	12.9
	No change	4	0.6
	Total	698	100.00
Quality of services compared to old services	Better	611	87.5
	Far better	68	9.7
	The same	19	2.7
	Total	698	100.0
Effect of KHETI on quantity of services	Use more agri-advice	672	96.3
	Use less agri-advice	2	0.3
	No difference	24	3.4
	Total	698	100.0
Quality Index (mean)	Before intervention	698	0.57
	After intervention	698	0.92

Source: Questionnaire survey 2008 & 2009.

Table 3. Regression results: impact of ICT on quality of extension services

	OLS Model 1		OLS Model 2		Tobit Model 1		Tobit Model 2	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Adopted *KHETI*	0.350***	0.005	0.350***	0.005	0.418***	0.009	0.418***	0.009
Age	0.001***	0.000	0.001***	0.000	0.001***	0.000	0.001***	0.000
Area in acres rented in	-0.002*	0.001	-0.002*	0.001	-0.003*	0.001	-0.003*	0.001
Area in acres rented out	-0.007**	0.003	-0.007**	0.003	-0.009**	0.005	-0.009**	0.005
Tropical livestock unit	-0.003	0.002	-0.003	0.002	-0.003	0.003	-0.004	0.003
Farmer's gender	0.002	0.008	0.004	0.008	-0.002	0.011	0.002	0.011
Middle school	0.000	0.011	0.005	0.011	-0.006	0.016	0.001	0.016
Primary education	0.009	0.006	0.007	0.006	0.013	0.009	0.010	0.009
Backward caste	-0.014	0.009	-0.020**	0.010	-0.019	0.014	-0.026*	0.015
Schedule caste or tribe	-0.009	0.010	-0.010	0.010	-0.016	0.015	-0.018	0.015
Access to credit	0.005	0.006	0.010*	0.006	0.004	0.008	0.011	0.009
Marital state	0.021*	0.012	0.022*	0.012	0.026	0.016	0.028*	0.017
Irrigation facilities	-0.037***	0.010	-0.040***	0.010	-0.047***	0.013	-0.051***	0.014
Agricultural assets	0.015***	0.006	0.013**	0.006	0.022***	0.009	0.018**	0.009
Village has buses			0.013*	0.007			0.018*	0.011
Village has electricity			0.020*	0.012			0.036**	0.017
Village economy envir.			-0.001***	0.000			-0.001***	0.000
Constant	0.538***	0.018	0.530***	0.021	0.530***	0.026	0.514***	0.029
N	1336		1336		1336		1336	
OLS R^2/Tobit sigma	0.76		0.76		0.135***	0.004	0.134***	0.004
Log pseudolikelihood					221.82		232.20	

Notes: *** significant at 1%, ** significant at 5%, * significant at 10%. White heteroskedasticity-corrected robust standard errors are reported here.
Dependent variable is quality index.
Sample: the treatment group before and after the intervention.

Table 4. Questions asked to SCPCL/*Munnas* and speed of answering them

	Post-intervention survey		Pre-intervention survey	
	Freq	Percent	Freq	Percent
Frequency of queries				
Daily	3	0.43	0	0.00
Many times in a week	45	6.45	0	0.00
Once in a month	8	1.15	1	0.14
Once in a week	36	5.16	0	0.00
When Needed	606	86.82	73	10.46
Not asked any question	0	0.00	624	89.40
Total	698	100.00	698	100.00
Speed of answers to the questions				
Quick	258	36.96	35	5.01
1 day	217	31.09	13	1.86
2-4 days	134	19.20	6	0.86
5 days or more	7	1.00	4	0.57
No answer/not asked any question	82	11.75	640	91.69
Total	698	100.00	698	100.00

Source: Questionnaire survey 2008 & 2009.

Appendix 1. Questions related to component attributes of quality of extension services and methodology of constructing indices.

	Minimum score	Maximum score	Indices Minimum	Indices Maximum
Questions asked to the farmers : From your experience, how useful is the advice from different sources of agricultural information / advice? [1=very bad quality, 2=bad, 3=acceptable, 4=good, 5=very good]				
Munnas/SCPCL	1	5	(1/5)=0.2	(5/5)=1
Other NGOs	1	5	(1/5)=0.2	(5/5)=1
Other farmers	1	5	(1/5)=0.2	(5/5)=1
Government extension services	1	5	(1/5)=0.2	(5/5)=1
Family	1	5	(1/5)=0.2	(5/5)=1
Radio	1	5	(1/5)=0.2	(5/5)=1
TV	1	5	(1/5)=0.2	(5/5)=1
Newspaper	1	5	(1/5)=0.2	(5/5)=1
Any other	1	5	(1/5)=0.2	(5/5)=1
Quality index QI for Munnas	1	5	(1/5)=0.2	(5/5)=1
Quality index (QI) for other sources	8	40	(8/40)=0.2	(40/40)=1

Appendix 2. Description of variables

Variable	Definition	Mean	St Dev
ICT_2	Farmers adopted *KHETI* services	0.579	0.494
Noinag	Number of persons in household in agriculture	2.253	1.042
Ownland	Area in acres owned by the farm household	3.090	3.362
encroach	Area in acre encroached by the household	0.431	1.544
Rentin	Area in acres rented in by the household	0.310	1.973
Rentout	Area in acres rented out by the household	0.091	0.696
gender_1	Farmer's gender (female=1)	0.120	0.325
edu_4	Farmer has middle school education=1	0.082	0.275
edu_5	Farmer has primary education=1	0.377	0.485
Eduhipls	Farmer has high school education and above=1	0.041	0.198
caste_2	Backward caste=1	0.529	0.499
Scst	Schedule caste or tribe=1	0.360	0.480
Credit	Farmer has access to credit=1	0.552	0.498
Rdtv	Farmer has radio/TV=1	0.069	0.253
Busv	Village has access to bus=1	0.721	0.449
Electv	Village has access to electricity=1	0.841	0.366
Villeco	Village economy measured by the total number of sample farmers in the village have access to electricity, mobile phone and TV	26.47	20.74
Age	Age of farmer (years)	38.812	12.641
Tlu	Tropical livestock unit	1.195	1.294
mstat_2	Marital status, married=1	0.942	0.234
Irfac_2	Farmers have irrigation facilities=1	0.191	0.393
Agas	Farmers have agricultural assets=1	0.430	0.495

[i] We verify the ICT adoption in two ways. First, the farmers were asked how often did they ask questions and how long did it take SCPCL/*Munnas* to answer queries. 74 member farmers asked SCPCL before the intervention. All 698 farmers asked questions in the post-intervention final survey and 616 of them received answers for their queries. This indicates that all member farmers are adopters of KHETI technology. Non-member farmers are not provided with KHETI services. Second, another question was asked to both members and non-members such that whether they are covered by SCPCL/*Munnas*. None of the non-members said 'yes' in the final survey.

[ii] $F_{3,1314} = 0.26$, prob>F=0.86 in the model with village level factors and $F_{3,1317} = 1.03$, prob>F=0.38 in the model without village level factors.