THE LITTLE WE KNOW: AN EXPLORATORY LITERATURE REVIEW ON THE UTILITY OF MOBILE PHONE-ENABLED SERVICES FOR SMALLHOLDER FARMERS

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Abstract: Mobile technologies could help to improve service delivery to smallholder farmers, but whether such services are fulfilling their potential remains poorly understood. To address this gap, this article presents an exploratory literature review regarding the impact of mobile phone-enabled services on farmers in developing countries. The review highlights a dearth of empirical evidence in this area. Findings suggest that farmers benefited through improvements in production planning, management of weather-related risks, and greater ease in receiving money. The review also points to several methodological shortcomings, notably the reliance on perception data and the failure to assess impacts in relation to usage. Copyright © 2017 John Wiley & Sons, Ltd.

Keywords: agriculture; innovation; mobile phone; m-service; information; markets

1 INTRODUCTION

The rapid evolution and uptake of digital technologies has been hailed as the ‘fourth industrial revolution’, which is characterised by ‘a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres’ (Schwab, 2016). Many believe that these changes hold great promise for developing country agriculture (e.g. Annan et al., 2016; Gates, 2016; Warshauer, 2016). As a report by the World Bank, the African Development Bank and the African Union note, ‘The strategic application of ICT [information and communication technology] to the agricultural industry, the largest...
economic sector in most African countries, offers the best opportunity for economic growth and poverty alleviation on the continent (Yonazi et al., 2012, p. 40).

In particular, the utility of mobiles phones to deliver services (referred to as m-services here) to farmers has received much attention. The rapid spread of mobile phones throughout the developing world offers opportunities to reach often remote, dispersed and poorly serviced farmers by overcoming barriers of space and social standing. Rapid technological advances in mobile technologies are predicted to further expand the range and usability of agricultural m-services in the future (Baumüller, 2017). In this article, ‘m-service’ is used as an umbrella term that subsumes commonly employed subcategories such as m-banking, m-payments or m-commerce. An m-service is understood to include the provision of mobile content (i.e. electronic media that are accessed through mobile phones such as images, audio recordings, graphics, videos or text) or functions offered through the mobile phones (such as banking facilities, marketplaces or social networking platforms).

To date, agricultural m-services are still far from fulfilling their assumed potential. According to a review by the GSM Association, they make up only a very small share of development-related m-services (8 per cent; Metcalfe, 2015). Many struggle to reach scale and financial sustainability (FAO, 2013, 2015; Hatt et al., 2013; Qiang et al., 2011). The reasons and remedies for this shortfall are still poorly understood, however. What is missing in current debates around the utility of agricultural m-services is a systematic review of the empirical evidence on their performance. As the FAO’s 10-year review of e-agriculture concludes: ‘solid information is needed regarding the impact of previous initiatives, including lessons learned, in order to inform the design and approach of future efforts’ (FAO, 2015, p. 39).

The most comprehensive review on the use of mobile phones for agricultural and rural development was presented by Duncombe (2012). However, most of the studies reviewed relate to mobile phone use in general rather than m-services. The latter are only touched upon, and the bibliography is incomplete. Another review published by Nakasone et al. (2014) assessing the impact of ICTs on agricultural development also does not distinguish between m-services and mobile phones, nor does it consistently differentiate between different ICTs. Moreover, the scope of the review is confined to just two impact channels of ICTs, that is, impacts of market information on prices and impacts of information on agricultural practices. Other reports on this subject (e.g. Aker, 2011; Donner, 2009; FAO, 2015; Gakuru et al., 2008; Qiang et al., 2011; Vodafone Group and Accenture, 2011; World Bank, 2011) tend to rely on a narrow selection of the literature, case studies and anecdotes. Other literature reviews related to mobile phones and m-services have focussed on micro and small enterprises (Donner and Escobar, 2010), financial services (Shaikh and Karjaluoto, 2015; Duncombe and Boateng, 2009) and m-commerce (Ngai and Gunasekaran, 2007) but do not offer insights related to farmers.

This article contributes to the available literature in several ways. First, it reviews the empirical literature on agriculture-related services that are developed for and offered through the mobile phone rather than the use of mobile phones in agricultural activities more generally (e.g. a service that regularly sends out information on market prices to subscribers rather than using the phone to call a buyer to ask about the current price). The focus on m-services was partly chosen not only because of the opportunities they may offer but also for methodological reasons. Given the widespread availability of mobile

1The majority of m-services are found in the health sector (43 per cent) followed by mobile money (20 per cent) and education (14 per cent).
networks and phones and consequently the lack of control groups without access to the technology, assessing the impact of mobile phones on farming operations has become very challenging. Studies on m-services allow researchers to focus on specific types of services that can be delivered through mobile phones, distinguish between users and nonusers through experimental designs and complement survey data through usage data collected through the device (although, as shown in the succeeding texts, this opportunity is rarely taken advantage of).

Second, the review focuses on a broad set of m-services rather than a subset of m-service (e.g. banking or information provision) in order to offer a comprehensive picture of their (predicted and actual) potential. Third, in addition to summarising and analysing the findings of the published research, the article also takes a critical look at the overall state of the related literature by reviewing the methods used in existing studies and identifying overarching research gaps.

The remaining article is organised as follows: Section 2 outlines the method used to conduct the literature review. Section 4 presents an analysis of the relevant empirical research. Section 5 highlights methodological weaknesses in the existing literature and challenges in mobile phone-related research in general. The final section offers conclusions and summarises the research gaps.

2 METHOD

An exploratory literature review was undertaken that builds on the approach set out by Arksey and O’Malley (2005). The review aimed at summarising and disseminating available research findings and identifying research gaps in the existing literature related to the following research question: What is known from the existing empirical literature about the impact of m-services on farmers in developing countries. Because of the small number of available studies (in particular from peer-reviewed sources) and the significant differences in the methods and data used, the literature did not lend itself to a more thorough systematic literature review or a meta-analysis.

Relevant empirical studies (in English) were identified by using academic databases (Science Direct, IDEAS, AgEcon and SSRN) and Internet search engines (Google and Google Scholar) with combinations of keywords such as mobile phone, ICT, ICT4D, m-agriculture, m-payments, agriculture, farmer, innovation, service and technology adoption. The terms were refined through an iterative process throughout the review. In addition, the snowball method was applied to identify relevant literature from reviewed articles.

Inclusion criteria to filter the search results were publication date, the type of intervention and the type of study. Only studies were selected that were published (or use data) after 2000 when mobile penetration rates started to expand significantly in developing countries. The focus of the research should be on m-services relevant to farmers in developing countries rather than mobile phone use among farmers more generally. The studies should involve an empirical impact assessment of an m-service, including a description of the methods used. Where services are offered through several dissemination channel (in addition to mobile phones), studies were only included if the data are disaggregated by channel because the studies otherwise do not offer insights specifically on the use of m-services. Given the limited number of relevant studies published in refereed journals, the literature review also includes grey literature provided
that the publications present information about the data and methods used. As a result, study quality was not used as an exclusion criterion.

Overall, 23 publications were identified as relevant, including nine journal articles, four conference papers, four book chapters, four reports and one webpage (summarized in Table 1). Most studies assess the impacts of information m-services, including information on prices (9), farming (9) and/or weather (6). Four studies examine mobile money services. Two studies look at mobile phone-enabled social networks for farmers. Only one study, each examined m-services offering training and access to inputs (labour). All studies use quantitative data, and 10 also gathered data through qualitative methods. Most of the research relies on survey data, collected in one (8), two (9), three (1) or an unspecified number (2) of rounds. Twelve survey-based studies included treatment and control groups, while 4 only surveyed the treatment group and 3 conducted a general household survey. Sample size varied widely between 47 and 1205. Only three studies analysed usage data gathered through the m-service. Most of the studies (12) analysed the data by using only descriptive statistics, while nine (also) employed inferential statistics.

The literature was analysed by collating the research findings and organising them thematically according to four categories of m-services. The categories were identified based on a review of the literature (e.g. Gakuru et al., 2008; Qiang et al., 2011; World Bank, 2011) and of the agriculture-related m-services available in developing countries. The categories include the following:

1. Services that disseminate information, for example, on agricultural practices, weather or disease outbreaks, or offer training.
2. Financial services including payment services, banking, loans and insurance.
3. Services that facilitate access to inputs (e.g. seeds, fertiliser, pesticides, water, electricity or labour), for instance, through information on suppliers or virtual marketplaces.
4. Services that facilitate access to output markets, for instance, through information on prices and buyers, virtual marketplaces and supply chain management systems.

In addition, the literature review served to identify research gaps related to the individual types of m-services and cutting across different services and the research area as a whole. Unlike the approach by Arksey and O’Malley (2005), this study also includes a quality appraisal of the methods used in the existing literature, although only at an aggregate level rather than with regard to the specific methods and analytical approaches in each study.

3 A REVIEW OF EMPIRICAL EVIDENCE: FACILITATING ADOPTION OF INNOVATIONS AMONG FARMERS

The following section summarises and analyses key findings from empirical research by using the four categories outlined in the preceding texts to assess available evidence and identify research gaps.
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TradeNet


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<td>India</td>
<td>Audio messages (push), helpline, social media platform with audio messages</td>
<td>Qualitative: usage data (call logs, transcriptions of recorded questions and answers) Qualitative: semistructured interviews</td>
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<td>SMS</td>
<td>Quantitative: 2 survey rounds (( n = 874 ))</td>
<td>Descriptive and inferential statistics</td>
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<td>Warana Unwired</td>
<td>Information service (farming)</td>
<td>India</td>
<td>SMS (pull)</td>
<td>Quantitative: 1 survey round (( n = 47 )), usage data (software logs) Qualitative: observation, structured and ad hoc interviews</td>
<td>Descriptive statistics</td>
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</tr>
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</table>
3.1 Information and Learning

M-services can play a role in improving access to information ‘due to their ability to support the decoupling of information from its physical repository’ (Bedi, 1999, p. 5). Specifically, information delivered through m-services can help farmers assess the suitability of an innovation and know where to access the innovation, when and how to use it, how to manage risks and where to sell the produce. Advice on farming practices is one of the most widely available information m-service in agriculture. In addition, m-services offering information related to the production environment (e.g. on weather or crop diseases) can assist farmers in better understanding and managing risks. M-services are also employed in educational initiatives and to facilitated social learning by offering platforms to exchange information and experiences.

Several studies have looked at the use of m-services to disseminate farming information in general. Three studies assessing the impact of voice-based information services highlight certain benefits. A study of LifeLines, a telephone-based advisory service for Indian farmers, finds that the majority of farmers reported that the service had improved their productivity, increased savings and earnings and decreased the need for loans (Haider Rizvi, 2011). Also in India, the use of the m-service Avaaj Otalo, which employs recorded voice messages to deliver and exchange information, led to reported changes in management practices, including increased use of effective pesticides and more extensive adoption of the lucrative but risky crop cumin (Cole and Fernando, 2012). The authors do not differentiate between the different functions of the service (automated voice messages, a helpline and a social media platform) when assessing impacts.

Conclusions differ on the impact of m-services on improving agricultural knowledge in general. In the case of Avaaj Otalo, most farmers appear to accept the advice on face value but did not show improved agricultural knowledge overall (Cole and Fernando, 2012). In contrast, a study of the Knowledge Help Extension Technology Initiative in India concludes that farmers had a higher awareness and knowledge of agricultural techniques but does not assess whether these changes also translate into behavioural changes (Fu and Akter, 2011). The m-service employs special phones operated by so-called munnas who record short dialogue strips (images and voice) to exchange questions and solutions on local agricultural problems. Interestingly, illiterate, poorer and landless farmers seem to have gained most, which the authors speculate may be because they had previously thought that modern ICTs only benefitted the rich and educated.

A study of M-Solution in India, which disseminates weather and farming-related information via SMS and audio messages, compares impacts between male and female farmers (Mittal, 2015). The majority of users felt that they had improved their knowledge of farming practices, increased yields and reduced costs. Weather information was generally judged most relevant followed by information on nutrient management and seeds. However, the prioritised information does not necessarily relate to the topics listened to or the actions taken. Thus, while respondents rank some topics as less important, the listening rates (i.e. average time of listening to a message) were nevertheless similar compared with priority issues. Also, while men and women had similar listening rates, women said that they had acted on less of the advice, including on weather information that only a majority of men said they had used to plan irrigation and input use. The author attributes this difference to women’s limited direct involvement in related decision making.

Two studies of the m-service Reuters Market Light (RML) in India, which provides farmers with information on weather, prices and farming practices, come to different
conclusions about the role of the service in changing agricultural practices. In both studies, a share of the farmers reported that they had changed their practices as a result of using RML. In the survey carried out by IMaCS (2011), almost two thirds of the farmers reported that the information had ‘slightly’ helped them adopt better practices and 19 per cent stated that it had helped ‘a lot’. In the second study, almost a third of farmers had changed crops between the two survey years (Fafchamps and Minten, 2012). Treated farmers were 14–20 per cent more likely to cite RML as a source of inspiration for the change than control farmers. However, the positive perception is not borne out by the analysis of the entire data set, which, in fact, shows that ‘treatment is found to have no effect on the propensity to change variety or on the reason for changing variety’ (p. 28).

Other studies have examined the provision of specific agricultural information. Three studies looked at the impact of weather information sent by SMS to farmers. One study in Colombia concludes that farmers who received weekly weather information reported 4–7 per cent less weather-related crop losses compared with the farmers in the control group who did not receive this information (Camacho and Conover, 2011). The survey of Indian farmers who were sent regular weather updates through RML shows that most (85 per cent) judged the information as useful. In contrast, Fafchamps and Minten (2012) do not find that the RML users were able to reduce crop losses after storms compared with control farmers.

A service disseminating information on the correct use of soil nutrients via SMS and voice alerts in India led to a perceived 15 per cent increase in incomes among intervention farmers compared with the control group, mainly through cost reductions because of the application of appropriate (i.e. lower) amounts of seeds and nutrients (Raj et al., 2011). Farmers were given individualised instructions for nutrient management and other crop cultivation practices via SMS and voice alerts, which they were then required to implement. The observed benefits might thus say more about the utility of the instructions than the mobile phone as a dissemination tool.

The use of m-services to facilitate education and learning among farmers has hardly been assessed empirically. One study examines the impact of the Lifelong Learning for Farmers initiative in India where training modules are recorded and disseminated to female livestock producers via mobile phones (Balasubramanian et al. 2010). The study concludes that the participants regard mobile phone-based training as useful and more convenient than face-to-face contacts because they could access the recordings at a time and place that suited them.

Only one study has examined an m-service to facilitate social learning and exchange, although much of the focus rests on usage rather than impacts. Patel et al. (2010) assess the performance of the social media aspect of Avaaj Otalo in India, which offers farmers a platform to ask questions via recorded audio messages, which are then answered by service provider staff or other farmers. The users valued in particular the possibility to listen to other farmers’ questions and the recorded answers. Interestingly, the majority (65 per cent) preferred to receive the information only from staff members. None of the farmers was interested in receiving answers only from other farmers and 35 per cent only if they were combined with staff advice.

3.2 Financial Services

M-payments allow farmers to pay for innovations and associated inputs and to sell their produce. Access and repayment of loans through the mobile phone can provide farmers
with the necessary financial resources to purchase innovations and to increase their willingness to bear the financial risk in case the technology does not perform well. M-banking facilities can also help farmers manage and earn interest on their savings, thereby enabling them to better deal with the seasonality of agricultural income and increase the choice of when and where to purchase which inputs. Finally, mobile phone-enabled insurance services can make insurance for smallholders viable by reducing the need for visits to insurance claimants, for instance, by monitoring weather events through weather stations or disbursing payouts via m-payments.

Three studies on the use of mobile phone-enabled financial services in the agriculture sector assess the impacts of m-payments on farmers. The studies do not distinguish between different service providers, but rather look at the use of m-payments more generally. Two of the studies document the rapid expansion of m-payment services in Africa. In Kenya, adoption among banana growers had increased from 60 per cent of farmers in 2009 to 91 per cent in 2010 (Kikulwe et al., 2014) while in Uganda adoption among coffee farmers had increased from 15 per cent in 2012 to 54 per cent in 2015 (Sekabira and Qaim, 2016).

The studies conclude that farmers most commonly use mobile money to receive money. Kikulwe et al. (2014) and Sekabira and Qaim (2016) find that withdrawing money from mobile accounts is the most frequent use of the service (60 and 70 per cent of farmers respectively) while use of m-payments to purchase goods or send money is less common. To what extent, the money withdrawn used for agricultural production is unclear. Only Kirui et al. (2012) provide information on how the money received is actually spent. They show that of the money received via m-payment services, the largest share is spent for agricultural purposes (32 per cent) followed by school fees (20 per cent) and food purchases (10 per cent). In contrast, m-payments are used less commonly for agriculture-related expenses, including inputs (7 per cent) and farmworkers (6 per cent).

The studies come to different conclusions regarding the determinants of m-payment service adoption. Higher education levels, larger household size and phone ownership seem to be important determinants as well as the distance to banks and mobile money agent. Distance to roads does not play a significant role, which according to the authors, highlights the potential of mobile money for remote areas (Kikulwe et al., 2014; Sekabira & Qaim, 2016). Kirui et al. (2013) and Kikulwe et al. (2014) find that wealthier male farmers are more likely to use m-payments, while Sekabira and Qaim (2016) do not find evidence in this regard. On the contrary, they suggest that female farmers may in fact benefit more from m-payments than male farmers.

The studies conducted in Kenya conclude that m-payment use had a significant positive impact on levels of commercialisations, input use and income (Kikulwe et al., 2014, Kirui et al., 2013). Similarly, Sekabira and Qaim (2016) find that m-payment users are more likely to sell coffee to buyers in higher value markets rather than local traders, enabling them obtain 7 per cent higher prices for their coffee. However, Kikulwe et al. (2014) also find that the main income gain because of m-payment use comes from increased remittances. Sekabira and Qaim (2016) attribute less of a role to remittances but rather to other off-farm income sources, such as running small-scale businesses in trade, transportation and

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Kirui et al. (2013) find that m-payment use increased the levels of commercialisations by 37 per cent compared with nonusers, input use by $42 and income from farming activities by 224$. Kikulwe et al. (2014) conclude that m-payment use is associated with increases in spending on inputs (except mineral fertiliser), commercialisation (19 per cent) and profits (35 per cent).
handicrafts, which are facilitated by m-payments. Kikulwe et al. (2014) and Sekabira and Qaim (2016) also highlight the utility of m-payment services for savings.

3.3 Agricultural Inputs

M-services can facilitate access to agricultural inputs, although they are not yet widely used for this purpose. For instance, m-services could disseminate information on input suppliers or input prices or provide trading platforms for inputs. Some services are also supporting access to water, for example, by allowing farmers to use their phone to switch water pumps on and off. Mobile phones also facilitate access to electricity, although somewhat indirectly, where mobile network operators have been providing excess power from their base stations to local communities. Some virtual labour markets have also been set up, although their use in the agriculture sector is still limited. Moreover, mobile phone-enabled financial services outlined in the preceding texts can facilitate the procurement of inputs.

The use of m-services to facilitate access to agricultural inputs has hardly been assessed. One study looks at the performance of the Berendina Employment Resources Centre in Sri Lanka, which uses a computerised database and mobile phones to match demand and supply for labour in rural areas. It finds that hardly any users took up the job offers provided through the centre because they did not trust offers received over the phone (Balasuriya and de Silva, 2011).

3.4 Output Markets

Various m-services provide information on market prices for crops and livestock, which could help farmers to evaluate the likely profitability of new technologies or by enabling them to obtain higher prices for the crops (e.g. through bargaining or access to buyers with better offers). In addition, the ability to profitably sell surplus produce for income generation will also depend on good access to markets. Mobile phone-enabled ‘virtual’ markets for agricultural products can help farmers link up to alternative buyers or markets, while m-payments can facilitate transactions between farmers and buyers. Another expanding m-service includes supply chain management systems that use mobile devices to manage produce sales, thereby simplifying sourcing from large numbers of smallholder farmers.

Several studies have looked at the use of m-service to facilitate participation in markets by assessing the impacts of price information and market linkages on production planning, income and producer–buyer relationships. Three studies conclude that m-services providing price information have helped farmers improve their planning. TradeNet users in Sri Lanka said that the information enabled them to make more informed decisions about the best harvest and selling times (Lokanathan et al., 2011). The assessments of Esoko in Ghana (CTED, 2013) and M-Farm in Kenya (Baumüller, 2015) show that the price information was most important at the sales stage but was also used earlier in the production cycle when deciding what to plant, albeit to a lesser extent. All of the studies used surveys to assess impacts and did not quantify actual changes in technology adoption, productivity or income.

Research findings on the impact of price information on the prices that farmers receive are mixed. Three studies conclude that farmers using m-services were able to obtain higher prices for their crops. In Bangladesh, all farmers who regularly received price updates through PalliNet felt that their income had improved as a result of using the service (Islam
and Grönlund, 2010). Using randomised control trials, Nakasone (2013) found that Peruvian farmers who received regular price information through SMS reported price increases, primarily for perishable crops. He attributes the increases to the improved bargaining power of the farmers. Similarly, users of TradeNet in Sri Lanka said that they had earned more for their produce (Lokanathan et al., 2011). While they did not seem to use the information for bargaining, they nevertheless felt that the traders offered them better prices because they knew that farmers were aware of prices in other markets.

An experimental study in Colombia comes to different conclusions, however. The research shows that many farmers who received daily price information via SMS were more knowledgeable of prices in different markets but did not receive higher sales prices than those who did not use the service (Camacho and Conover, 2011). The study compared prices recorded by farmers with average daily prices collected by the Corporación Colombiana Internacional. The authors do not offer an explanation for this finding.

The two studies of RML also show limited impacts on prices. IMaCS (2011) finds that 58 per cent of the farmers did not feel that the price information had helped them increase the market value of their products. Just over a third (36 per cent) reported increases of 1–5 per cent and the remainder 5–6 per cent. The authors explain the limited impact by the fact that the surveyed farmers mainly sold at local markets for which no price information was available. Fafchamps and Minten (2012) conclude that farmers with a free 1-year RML subscription did not receive significantly higher average prices. They also note that the RML subscription did not impact transaction costs nor did it induce farmers to economise on the cost of searching for price information. The authors explain that most farmers sell at the nearest wholesale market, thus limiting their opportunities for arbitrage. Nakasone (2013) further speculates that the lack of impact could be explained by the fact that the study targeted market-oriented farmers who may already be aware of market prices.

Two studies of Esoko also highlight the challenges in drawing clear-cut conclusions about price impacts. One study finds that users obtained higher prices for yam (11 per cent), but not for maize, cassava and gari (processed cassava; CTED, 2013). To explain the difference, the authors point out that bargaining is more common in the case of yam marketing than other crops. This hypothesis is supported by the fact that around two thirds of farmers said that they had used the price information to bargain with traders. In contrast, another study of Esoko concludes that farmers with access to the m-service received 10 per cent higher farmgate prices for maize and 7 per cent for groundnuts than the control group (Courtois and Subervie, 2014).

Three studies that have looked at the impact of m-services on trading patterns do not observe significant changes. A study of PalliNet in Bangladesh finds that around a third of farmers with access to price information had switched markets at least once, but most preferred to stay in the same market because they were not familiar with the business mechanisms in other markets (Islam and Grönlund, 2010). Similarly, the TradeNet study notes that users with access to information about different traders (through the TradeNet marketing platform) largely continued to sell to the same traders because they depended on them as a source of loans and information (Lokanathan et al., 2011). An assessment of the price information service M-Farm in Kenya also finds little evidence of changes in sales patterns (Baumüller, 2015).

None of the studies has assessed the effectiveness of mobile phone-enabled agricultural markets. Anecdotal evidence suggests that ‘virtual’ market places may need additional support measures if they are to reach smallholder farmers. Reviewing past experiences with Cellbazaar, the founder Kamal Quadir and his colleague Naeem Mohaiemen reflect that
uptake had been faster in urban than rural areas (Quadir and Mohaiemen, 2009). Reaching farmers was found to take some additional effort in the form of ‘human translation or help’ (p. 71), including training through public and private institutions.

Empirical research into the effectiveness of mobile phone-enabled supply chain management systems is still limited. An internal review by the Kenyan company Virtual City of its Agrimanagr service, which uses mobile technologies to track produce deliveries from small farmers to processors and sellers, shows improvements in efficiency (Virtual City, 2009). Specifically, the review finds that the system had reduced the delay in payments to farmers from 120 to 31 days because of a faster consolidation of reports, cut purchasing times from 3 minutes to 22 seconds and increased the average produce weight per transaction by 9–13 per cent with the use of electronic weighing technologies.

3.5 Cross-Cutting Issues and Research Gaps

The previous sections have highlighted the limited conclusive evidence on the utility of specific types of m-services. In addition, a number of overarching research gaps cut across the literature.

Hardly any studies have looked into behavioural factors that influence farmers’ willingness and ability to use m-services. Attitudes to risk, for instance, play an important role in agricultural technology adoption. While none of the studies looked at the role of risk attitudes in m-services adoption, several studies on mobile phone use in general highlight the importance of trust as a prerequisite for people to use their phone in business transactions (Galperin and Mariscal, 2007; Jagun et al., 2007; Mascarenhas, 2010; Molony, 2006). Research into the usability of m-services needs to involve comparisons between different designs of m-services, for example, how the service is delivered (e.g. voice, SMS and Internet), how it can be accessed (e.g. push or pull) or how much should be charged. Only one study compared delivery mechanisms within an m-service by offering farmers market information either automatically (the ‘push’ group) or on demand (the ‘pull’ group; Islam and Grönlund, 2010). The information was considerably more effective for farmers in the push than in the pull group.

The utility of mobile phones vis-à-vis other channels to deliver a service and the complementarity between different channels has received little attention. Some evidence has emerged from research into information m-services. Two studies look at changes in preferred information sources prior to and after the introduction of the m-service. In India, SMS from RML became by far the main source of information for weather information (previously TV), market prices (previously traders), crop advice (previously ‘other’) and government schemes (previously local newspapers; IMaCS, 2011). Similarly, the introduction of M-Farm in Kenya led to a decline in the importance of traders and market buyers as a source of price information (Baumüller, 2015). While some farmers continued to obtain information from middlemen, the quality of information was generally seen as worse than M-Farm. The study of KHETI also finds that the large majority of treated farmers regard the m-service as faster and better quality than traditional extension services (Fu and Akter, 2011).

Veeraraghavan et al. (2009) assess the Warana Unwired project that involved switching from a PC-based to an SMS-based system to transmit information to and from members of a sugarcane cooperative in India. Farmers could request information through their mobile phone or by using a phone in the village kiosks that also housed the PCs. Kiosk owners
collected information on fertiliser and water use. The SMS-based system was generally well received. Advantages over the PCs include the battery power, mobility, fast access anytime and democratisation of access. However, PCs were still preferred for entering longer text, for example, on fertiliser use.

Two studies comparing different dissemination channels for price information find the radio to be a popular channel. The study of M-Farm shows that the radio is regarded as a viable alternative to the m-service, in particular in the early stages of production. M-Farm gains in importance at the sales stage, possibly because of the time sensitivity of the information and the ability to store price information on the mobile phone (Baumüller, 2015). Comparing market information provided through radio and mobile phone, Ferris et al. (2008) find that farmers preferred to receive the information through the local radio stations even though almost all of them had access to a mobile phone. Many farmers were not aware of the price information service available through SMS and were not used to using their mobile phone to access business information. However, the authors predict that SMS will become more desirable in the longer term because they are cheaper and can be accessed and updated more easily.

Impact studies rarely distinguish between user groups who may differ, for instance, by gender, income, social standing or religion. Usage and impacts, however, can vary considerably between these groups. For instance, the studies of farmers’ use of m-payments in the preceding texts suggest that that farmers with a higher level of education are more likely to use the services. Gender-related factors can also play an important role but rarely feature in existing research on agricultural m-services. The study of M-Farm in Kenya finds that women felt empowered by their participation in the training in how to use the m-service because it had familiarised them with the use of the mobile phone, which they were then able to use for other purposes. Also, as elaborated in the preceding texts, Mittal (2015) shows that women are equally interested in the information but appear less able to act on it because of other constraints.

Further research is also needed on how usage of m-services differs between those who own a phone and those who share someone else’s. One study comparing mobile phone owners, nonowning users and nonusers in Tanzania observes that owners used phones for a greater variety of purposes, while nonowning users mainly used phones to contact family members or for business reasons (Goodman, 2005). A study of Ugandan farmers also shows that households that did not own a mobile phone could still benefit from the availability of mobile phones in the community, for instance, when someone in the village arranged the collection of produce with a trader (Muto and Yamano, 2009). Understanding these differences is particularly important when studying m-service usage and impact among low income groups where phone sharing is more common (de Silva and Zainudeen, 2007).

Finally, as also highlighted by Duncombe (2012), not enough attention is paid to the context in which the m-service is provided to understand how other factors may influence the utility of the service. Some of the studies of marketing-related m-services have sought to explain limited impacts by referring to other constraints that prevent farmers from taking advantage of price information or marketing choices (Fafchamps and Minten, 2012; IMaCS, 2011; Islam and Grönlund, 2010; Lokanathan et al., 2011). Only one study systematically assesses the relative importance of different factors. The study concludes that lack of information about prices and buyers is far less important to farmers than other constraints, such as lack of finance or risk of crop losses (Baumüller, 2015). Various studies into the use of mobile phones in marketing more generally also find that other factors such as established business relationships, the perishable nature of the produce,
limited storage facilities or trust are more influential in making sales decisions than price information or market linkages (e.g., Burrell and Oreglia, 2015; Frempong et al., 2007; Galperin and Mariscal, 2007; Jagun et al., 2007; Kameswari et al., 2011; Mittal et al., 2010; Molony, 2006; Tadesse and Bahiigwa, 2015)

4 METHODOLOGICAL SHORTCOMINGS AND CHALLENGES

The review of the literature points to certain methodological shortcomings in the research on agricultural m-services. Such shortcomings are not only found in this sector. A review of assessments of m-health applications in low and middle income countries finds a lack of rigour in the design and methodology of most studies (mHealth Alliance, 2012).

Much of the reviewed research relies on farmers’ perceptions obtained through surveys rather than time series data gathered by data collectors or by analysing actual usage patterns. Two studies indicate that m-service users may, at times, be overly enthusiastic when reporting impacts. In the case of RML, a large proportion of farmers in the treatment group mentioned the m-service as the inspiration for changing agricultural practices. Thus, it could be expected that more farmers in the treatment group had changed their practices. However, as explained in the preceding texts, the researchers did not find supporting evidence in this regard (Fafchamps and Minten, 2012). In the case of M-Farm, farmers reported that they usually received equally good or better prices than those quoted by M-Farm. However, when comparing M-Farm prices for sweet potatoes with actual prices received, the study finds that actual prices were almost always lower (Baumüller, 2015).

A major shortcoming of the existing research is that most studies do no assess impact in relation to usage. Rather, research tends to distinguish between users (or those with access to the m-service) and a control group, and then compares impacts for the entire groups irrespective of usage patterns. Haider Rizvi (2011), for instance, observes that the usage frequency of LifeLines was generally low and varied widely between weekly and twice a year but does not differentiate by usage in the impact analysis. Similarly, Fafchamps and Minten (2012) note that only 59 per cent of farmers who had been offered a free RML subscription actually used it but carry out much of the analysis by using intent-to-treat estimates for farmers who were offered a free RML subscription irrespective of whether they used it. A similar approach is taken by Cole and Fernando (2012) in the case of Avaaj Otalo, although only 58 per cent of treated farmers had called the helpline and 65 per cent had listened to push content. Similarly, none of the m-payment studies relate the assessment of determinants and impacts to actual usage of m-payments for agricultural purposes. In the case of Kikulwe et al. (2014) and Sekabira and Qaim (2016), data on agriculture-related m-payment use are not provided. While Kirui et al. (2012, 2013) offer these data at least in aggregate form, they do not use it for their analysis. In the absence of usage data, establishing causalities between the m-service and observed changes is difficult.

At the same time, it is important to note that impact studies of m-services are subject to several methodological challenges. The impact of the m-service can be difficult to isolate from the use of the phone in general. If farmers are introduced to an m-service, it may induce them to use their phone more readily for other purposes. The study of M-Farm shows that women farmers who had participated in M-Farm training started using the phone for other business transactions as well (Baumüller, 2015). The study of KHETI also finds that treated farmers were generally more open to using new agricultural and mobile technologies after they started using the m-service (Fu and Akter, 2011). Two studies tried
to deal with this challenge by preventing the participants from using the mobile phone they were given to access the service to make or receive other calls (Nakasone, 2013; Mitra et al., 2013). However, the researchers would not be able to prevent the participants from using their own phones.

Isolating impacts becomes even more complex where an m-service offers several functions (e.g. different types of information, delivery channels or types of services) or is part of a larger support programme. Indeed, many researchers do not attempt to distinguish between the different functions (e.g. Cole and Fernando, 2012; Fafchamps and Minten, 2012; Mitra et al., 2013). One study that separately assesses impact of the price information and the selling services finds that *M-Farm* users were often not able to differentiate between the impacts. The farmers also attributed impacts to the m-service, although they were in fact a result of the umbrella project implemented by the local partner (Baumüller, 2015).

Randomised control trials may be most suitable for the study of m-services because providers are able to control and measure usage of the service. However, such research nevertheless risks contamination because the conditions under which the interventions are implemented are often difficult to control (Barahona, 2010). For instance, in the case of publicly available m-services, anyone is free to subscribe. Lokanathan et al. (2011) note that, although *Tradenet* was only mentioned to the treatment group, farmers in the control group had also heard of the service through word-of-mouth and advertising.

Avoiding contamination is particularly challenging in the case of information services given that information spreads easily (including through mobile phones). To what extent information spillover may occur is difficult to predict. Baumüller (2015) finds that many farmers share price information they receive via SMS with other farmers within and even more frequently outside their farmers’ group (38 and 62 per cent respectively). Courtois and Subervie (2014) also detect evidence for price information spillover, although more commonly within than outside the community. Similarly, Mittal (2015) shows that almost all farmers share price information with other farmers, often on a weekly or even daily basis. In contrast, Nakasone (2013) finds no impacts on marketing outcomes among households in the same village that did not have access to the price information services.

5 CONCLUSIONS

The literature review points to a dearth of empirical evidence regarding the impact of m-services on farmers in developing countries. Even studies assessing the same m-service often come to different conclusions. Some preliminary insights can nevertheless be summarised with regard to information and marketing m-services, which have been the focus of the majority of the research. Farmers often report to have benefitted from information m-services, mainly through improved production planning and better management of weather-related risks. However, perceived price gains are not necessarily borne out by other evidence. M-payment services mainly benefit farmers by enabling them to receive money more easily. With regard to output markets, most studies concur that m-services have had limited impacts on trading patterns, which remain largely unchanged.

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5 The study of potato farmers in West Bengal, India, assesses impact of access to price information via mobile phones or an information board but does not differentiate between dissemination channels in the data analysis (Mitra et al., 2013). The findings were therefore not included in the literature review.

6 The authors do not provide data on whether and how participants in the control group used the service.

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because of other constraints. With regard to m-services offering supply chain management, access to inputs, education and social networks, research findings are too limited to draw any meaningful conclusions. To the author’s knowledge, no study has looked into the utility of mobile-phone enabled loans, savings, insurance and output markets for farmers.

In addition to research gaps related to specific types of m-services, several overarching gaps are also found in the literature. Hardly any research has compared the utility of different delivery channels both within the m-service (e.g. voice versus SMS) and between different types of channels (e.g. mobile phones, radio, TV or face-to-face contact). Also, most studies do not differentiate between different user groups, although the propensity and ability to use an m-service may differ considerably. Further research is also needed on difference in usage and impacts between those owning and sharing phones. Finally, m-services are rarely assessed within the context in which they are provided. While some studies have looked at the farming context to explain their findings, most do not systematically assess the influence of contextual factors as part of the research question.

The literature review has also shown that existing research suffers from several methodological limitations. The vast majority relies on farmers’ perceptions rather than time series data that provide only weak evidence when assessing actual impacts. Indeed, some studies show that farmers are often overly enthusiastic about the benefits of the m-service and struggle to recollect prices or income. In future research, baseline studies prior to launching the service, including both surveys and other numerical measurements gathered by independent data collectors, would be needed to better understand changes over time. Impacts should also be assessed in relation to actual usage patterns rather than only users versus nonusers. At the same time, some methodological challenges may be difficult to address, such as spill-over effects of mobile phone use, leakage of information or isolating impacts where m-services offer multiple functions. Carefully designed experimental studies may help to address these challenges at least to some extent.

Based on the review, some conclusions can be drawn regarding the types of m-services that would benefit and can potentially be marketed to smallholder farmers. Importantly, the m-service should offer economies of scale so that service providers can target a large customer base at affordable rates while keeping costs low. Examples of promising applications include largely automated information services, insurance pay-outs triggered by sensory data, mobile banking or supply chain management using mobile technologies to collect and transmit delivery data. Price information, on the other hand, may be less suitable because the localised and timely information required by smallholder farmers is costly to gather. Mobile phone-enabled business-to-business relations among farmers and buyers would require standard setting and quality controls and large investments in logistics infrastructure. Yet, new logistics and infrastructure improvement in low and middle income countries may facilitate their evolution soon.

M-services will also be more suitable for smallholder farmers if the complexity of services is handled by the service provider or intermediaries, such as collection points, processors, financial institutions, extension agents, farmers’ organisations, agro-dealers or dedicated m-service agents. Moreover, the context in which the services are provided will be crucial in determining its success, such as existing trust relationships, access to markets or availability of inputs and credit. The strengthening of legal and other institutional systems may be a critical condition for ICT effectiveness in rural areas. It is also important to bear in mind that technologies and people change and, with that, the opportunities for providing m-services to smallholder farmers. Further research could explore these and other factors to inform the design of m-services in the future.
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