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Social Factors That Influence Use of ICT in Agricultural Extension in Southern Africa

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Abstract: Farmbook is a novel information communication technology (ICT) tool for agricultural extension that is currently being field tested by the Catholic Relief Services (CRS) in Southern and East Africa. Farmbook enables extension agents to assess productivity and profitability of farming enterprises in a faster and more reliable manner, so as to increase farmer incomes and achieve food security. This study looked at the relationship between challenges faced by extension agents testing the Farmbook application and select socio-economic indicators influencing their work. Specific objectives were to identify and categorize the challenges facing extension agents in the field as they used Farmbook, assess gender differences in the use of Farmbook by extension agents, understand the relationship between socio-economic status of extension agents and the challenges faced in using Farmbook. Data were collected through document reviews, administration of a structured questionnaire and focus group meetings with field agents. Descriptive statistics and multivariate techniques were used to analyze data. The results show that personal and wider socio-economic conditions do have an impact on the proficiency of extension agents using Farmbook. The study goes on to recommend measures to improve the training and ICT proficiency of extension agents adopting Farmbook.

Keywords: Farmbook; ICT; Catholic Relief Services; agricultural extension; Zambia; mosaic plots

1. Introduction

As the world's present population grows from 6.7 to 9.1 billion by 2050, food production will need to double over this same period [1]. Thus, more effective extension services are needed to address agricultural challenges including meeting the information needs of poor smallholder farmers in developing countries. In response, agricultural extension experts and institutions around the world are promoting the use of Information and Communication Technology (ICT) by agricultural extension and education agents. ICTs can expedite the process of agricultural technology transfer from research and development institutions to farmers. ICTs improve adoption of agricultural technology by supporting farmer learning, problem solving, and accessibility to profitable markets for their crops [2].

Research findings reveal that ICTs do improve the productivity and livelihoods of poor smallholder farmers [3]. Interestingly, Anastasios *et al.* [4], in their study of ICTs as agricultural extension tools in Greece, found that ICTs supplement rather than replace traditional extension methods. A study exploring the use of ICTs by extension agents in the Caribbean found that they use ICTs for personal benefits and increased professional productivity, but also continue to use traditional interaction methods with farmers [5]. However, Lasley *et al.* [6] have expressed the view that ICTs could eventually replace traditional information and training systems used by extension services and even alter the role of extension agents.

Socio-economic factors have been cited as major determinants of extension agents' use and eventual adoption of ICTs. Akpabio *et al.* [7] found that poor ICT infrastructural development, high cost of broadcast equipment, high charges for radio/television presentations, high cost of access/interconnectivity and electricity power problems were amongst the constraints affecting ICT utilization by agricultural extension officers in the Niger Delta, Nigeria. Anastasios *et al.* [8] showed that Internet access in rural Greece was influenced by income and gender for "basic users", by the existence of a young member in the family for "interactive users", and by the digital divide between rural *versus* urban location and farmer's competency for the "farm oriented users".

In addition, Mwombe *et al.* [9] showed that age, gender, income and acreage of bananas planted had an influence on the intensity of use of ICT tools, as a source of agricultural information for smallholder banana farmers in Gatanga district, Kenya. Results from a comparative study on ICT use in agriculture in Botswana, Ghana, Kenya and Uganda found that low capacity and inadequate infrastructure were major challenges to ICT use in agriculture [3]. The study showed that although cellular phones, the Internet, radio, and web-based applications have become increasingly important in sharing and disseminating agricultural information and knowledge, and in marketing goods and services, there is low capacity and usage of ICTs and that inadequate ICT infrastructure in rural areas is a major problem.

In view of these findings that socio-economic factors influence the adoption of ICTs by agricultural extension agents, this study seeks to understand how socio-economic factors influenced the pilot roll-out of Farmbook, a new ICT tool, among extension agents in Southern Africa. The study proceeds by assessing the relationship between challenges faced by extension agents using Farmbook and select socio-economic indicators including gender. The study is informed by the Diffusion of Innovation (DoI) theory [10].

1.1. What is Farmbook

Farmbook is an ICT application developed and currently being field tested by the Catholic Relief Services (CRS) at the request of a consortium of non-governmental organizations (NGOs), under the Southern African Agro-Enterprise Learning Alliance. Farmbook enables extension agents to help farmers plan their businesses, assess productivity, and profitability of their farming enterprise. This application was also developed as a means to manage field agents and to help remote field agents to easily share their data with project managers [11]. It also allows field agents to register people into households, register farmers into farmer groups, enables farmers to run profitability analyses for specific products, enables farmer groups to develop business plans, supports crop production scheduling and allows field agents to record farm visits, training and assets transferred.

This application provides farmers with access to a business planning software that is focused on improving their product and market opportunity [11]. It provides customized business plans that can help individual farmers analyze farm preparation costs, type and cost of investment loans, sales, revenues and profits. The analysis generated can be printed by the field agents and shared with farmers on their return visits. The data generated from Farmbook can also be used for overall monitoring and evaluation.

1.2. Theoretical Framework

This study is informed by the Diffusion of Innovation (DoI) theory [10]. Rogers defined diffusion as "a process by which an innovation is communicated through certain channels over time among members of a social system" [10]. The theory presumes that a new idea, practice or object is adopted based on its perceived attributes, the social system in which it is diffusing, communication channels and the length of time the idea has been around [10]. The theory presents five attributes that make an innovation attractive, namely perceived relative advantage, compartibility, complexity, trialability and observability of the results of the innovation to potential adopters.

This theory has been widely used to inform the design of several information systems projects, and in managing the diffusion of agricultural innovations [12,13]. An important critique of Rogers diffusion theory is its inherent assumption that diffusion is a one-way top-down process from sender to receiver; development communication experts now acknowledge that effective adoption of innovation is more likely through participatory processes than through top-down processes [14]. Rogers diffusion theory also focused more on the perceived attributes of the innovation as the driver of adoption and less on the social and economic factors [15,16]. This study thus contributes to understanding the role of social and economic factors in the diffusion of innovation.

In this study diffusion is viewed as a process by which the innovation, in this case Farmbook, is communicated through certain channels, including public and private extension systems, farmer based organizations, and farmers groups over time among smallholder farmers (particularly farmers doing farming as a business or collective marketing). In this study, Farmbook is presented as an innovation that can be used to substitute the traditional business planning methods currently used by extension agents in developing countries. The traditional process of business planning is lengthy, time consuming, performed with paper and pen, is highly prone to error, difficult to conduct on a large scale, and high in transaction costs.

1.3. Objectives

The overall objective of this study is to assess the influence of select socio-economic factors on adoption of Farmbook ICT by extension field agents in Southern Africa. Specific objectives were:

1. To identify and categorize the challenges hindering extension agents from the effective use of Farmbook
2. To understand the relationship between selected national development indicators and the effective use of Farmbook by extension agents
3. To assess gender differences in the use of Farmbook by extension agents
4. To understand the relationship between socio-economic status of extension agents and the challenges faced in using Farmbook
5. To understand the relationship between proficiency in the use of the Internet and the use of Farmbook by extension agents
6. To recommend adaptive measures to improve the training received by extension agents adopting Farmbook in order to enhance their effective use of the technology

1.4. Research Question and Hypothesis

An effective agricultural and advisory system must increase farm household income, build social capital, achieve household food security, improve family nutrition and education and achieve long-term food security [17]. However, for this to happen, extension agents must have the right tools to work with and the competence to use these tools effectively. Given that Farmbook technology is one of such novel tools that is being introduced and adopted by extension agents, their competence in the use of this new technology will be directly related to personal and societal socio-economic conditions affecting their work [18,19]. The key question guiding the research reported in this paper is therefore as follows:

- *What is the relationship between challenges faced by extension agents using Farmbook and the personal and societal socio-economic context influencing their work?*

Following from this, the research null hypothesis guiding this study is as follows:

- *Personal and wider socio-economic context have no impact on challenges faced by extension agents using Farmbook.*

2. Experimental Section

Materials and Methods

Farmbook was introduced to extension field agents in Madagascar, Malawi, Zambia and Zimbabwe by CRS through two extension training workshops in 2012. The first workshop took place in Malawi from 23 to 27 April 2012 with a module introducing Farmbook to the participants. The second workshop took place in Zambia from 22 to 28 August 2012 and included a module on field level monitoring of the use of Farmbook. A third workshop was held in Zambia from 23 to 30 January 2013 and this enabled CRS to assess the challenges faced by field agents using Farmbook. Data analyzed in this paper was partly obtained during the third workshop in Zambia, where the researcher had the opportunity to hold focus group discussions with extension agents who had earlier received the study questionnaire. A total of five focus group meetings were held with extension agents from the four countries involved in this study.

Data were collected through the use of a structured questionnaire that was e-mailed out from November 2012 to January 2013 to extension agents who had received Farmbook training. The questionnaire was first pre-tested with 10 extension agents from the target countries to determine the effectiveness of the questions. Feedback from the pre-testing exercise enabled the researchers identify questions that were confusing to respondents and those that could lead to bias answers. The questionnaire was then revised, improved, finalized and ready for distribution by e-mail. Respondents were contacted by email and asked if they would like to participate in the study. Questionnaire were emailed out to respondents who were interested along with an informed consent form. A total of 40 questionnaires were emailed out by January 2013 to extension agents in Madagascar, Malawi, Zambia and Zimbabwe, who had received Farmbook training. Completed questionnaires were received from 30 extension agents giving a response rate of 75%.

From a technical-architectural point of view, the design process of the questionnaire is divided into six levels of functionality as follows: The first section had questions on demographics, the second had questions on extension agent field presence, the third had questions about capacity, the fourth had questions related to challenges working with farmers, the fifth had questions related to the CRS training and the use of Farmbook, and the sixth section had questions related to Internet accessibility. This paper focuses on responses received to questions related to the use of Farmbook.

Data were analyzed using both descriptive statistics and multivariate techniques using JMP 10 statistical software. The questionnaire responses were first entered into Excel software and categorized; it was then imported into JMP 10 statistical software for contingency analyses. Contingency analyses show the distribution of a categorical variable Y across the levels of a second categorical variable X. The data was tested for internal consistency reliability through a correlation of responses to question 36 "*do you have a smart phone*", and question 37 "*state the name of your smart phone*", in our questionnaire. The Spearman's rank correlation coefficient for Q36:37 is r = 0.93. The very high correlation coefficient implies a high reliability of the questionnaire responses. Results from our contingency analyses are provided in the form of mosaic plots—a graphical method for presenting and understanding results from qualitative analyses.

The research methods employed in this study were used by Chipeta *et al.* [20] in their assessment study of the Swedish International Development Agency's agricultural extension pilot project in Zambia. The method was also used by Belay and Abebaw [18] in their research which examined challenges hindering the adoption of modern extension technologies in Ethiopia.

3. Results and Discussion

3.1. Respondents' Demographic Characteristics

The questionnaire survey was carried out with 40 research participants in all and there was 75% response rate. Our data shows that 6.7% are from Madagascar, 33.3% from Malawi, 23.3% from Zambia

and 36.7% from Zimbabwe. In addition 76.7% were male and 23.3% were female giving a ratio of 3:1. Age distribution was from 22 to 50 years, with an average of 35 years; with 46.7% below 35 and 53.3% above 35 years. On the academic front 23.3% had high school qualifications, 20% had professional qualifications, 46.7% had Bachelor's degree, and 10% had Masters' degree. Lastly, on the broad job description of respondents, 66.7% are principally field-based while 33.3% are office-based, giving a ratio of 2:1.

3.2. Farmbook Challenges and Country of Research Participants

The mosaic plot in Figure 1 shows the relationship between the variables "Farmbook Challenges" (Y) and "Country" of research participant (X). The width of the bars represents the comparative sizes of the data points in the variable "country" on the (X) axis.

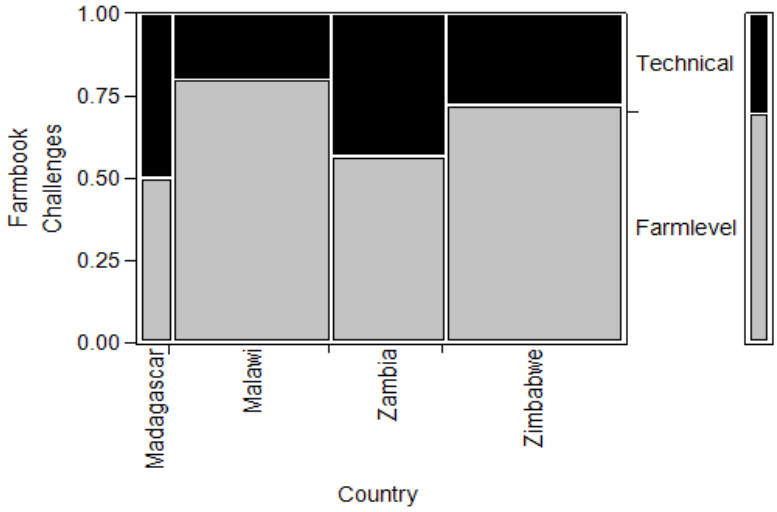

Figure 1. Challenges to using Farmbook and country of research participants.

The height of the bars in Figure 1 represents the variable "farmbook challenges" on the (Y) axis. This has two data points: "farmlevel challenges" and "technical challenges". Farmlevel challenges are related to the context in which the farmer operates. Responses to the question "challenges using farmbook" such as "absent farm records", "low farmer literacy", "low farmer IT skills" were categorized as "farmlevel challenges". Technical challenges include responses such as "software malfunction", "low Internet connectivity", and "insufficient technical support".

In mosaic plots, the lone standing bar on the far right shows the aggregate ratio of the (Y) variable. Thus in Figure 1, about 75% of the research participants reported experiencing more farmlevel challenges than technical challenges. However, when this is disaggregated according to the country of research participants, those from Malawi and Zimbabwe experienced more of farmlevel challenges compared to those from Madagascar and Zambia.

3.3. Relationship between Farmbook Challenges and Gender

Women in our dataset reported facing more farmlevel challenges compared to their male colleagues; conversely women reported lower occurrence of technical challenges to using the Farmbook ICT application compared to their male colleagues (Figure 2). These results are similar to several studies [21] that show that women tend to have lower levels of education compared to men, which limits their active participation in training that uses a lot of written material and thus the inability to keep farm records.

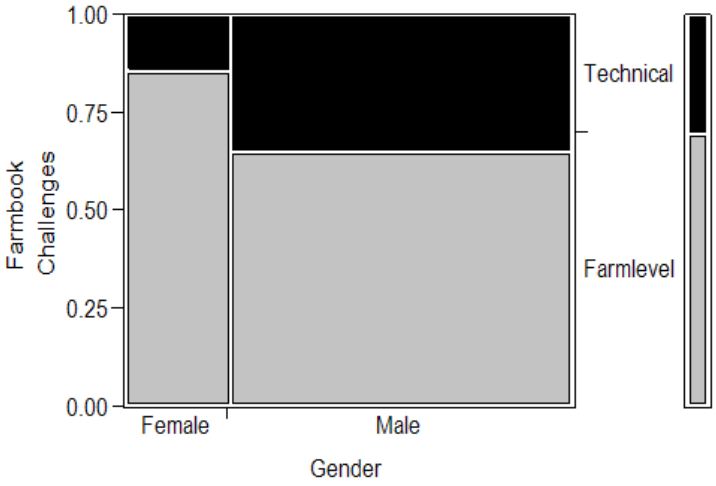

Figure 2. Challenges to using Farmbook and gender.

3.4. Relationship between Farmbook Challenges and Age

Extension agents 35 years and above reported experiencing more technical problems compared to those below 35 years in their use of the Farmbook application (Figure 3). We also observed that the younger agents (those below 35 years) were more enthusiastic about Farmbook and were eager to learn about the application compared to agents 35 years and above.

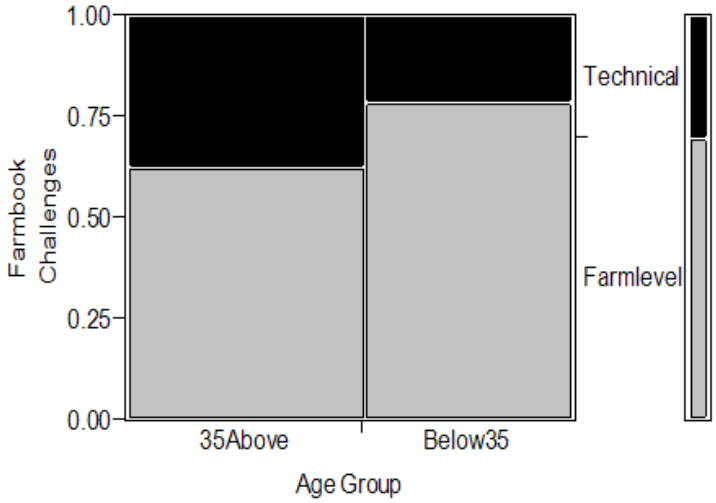

Figure 3. Challenges to using Farmbook and age group of extension agents.

3.5. Relationship between Farmbook Challenges and Educational Qualification

Figure 4 shows that a higher ratio of Bachelor's degree holders' reported experiencing technical challenges with the use of Farmbook compared to the High School certificate holders. Those with professional qualifications experienced much more of farmlevel challenges than technical challenges with the Farmbook application. However, none of the masters' degree holders reported experiencing any technical challenges with using Farmbook. These results are similar to those of Strong *et al.* [5], who found that educational levels of extension officers played a role in technology acceptance with higher levels of education earned resulting in an increase in technology use. Doss and Morris [22] found that educational level was one of the most commonly cited binding constraints in technology adoption.

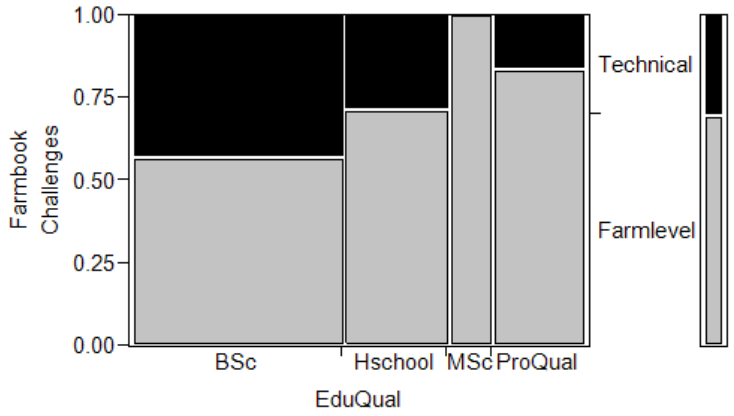

Figure 4. Challenges to using Farmbook and educational qualification.

The results suggest that the highly educated extension agents, those with Master's degrees, could be trained on the more sophisticated aspects of the Farmbook technology so that they can fulfil the role of providing technical support to the others.

3.6. Relationship between Farmbook Challenges and Ability to Use the Internet

Figure 5 reveals that the more comfortable extension agents are with using the Internet the less the ratio that reported experiencing technical challenges with Farmbook. Extension agents who were excellent at using the Internet were most comfortable with Farmbook technology and those least able to use the Internet were most uncomfortable.

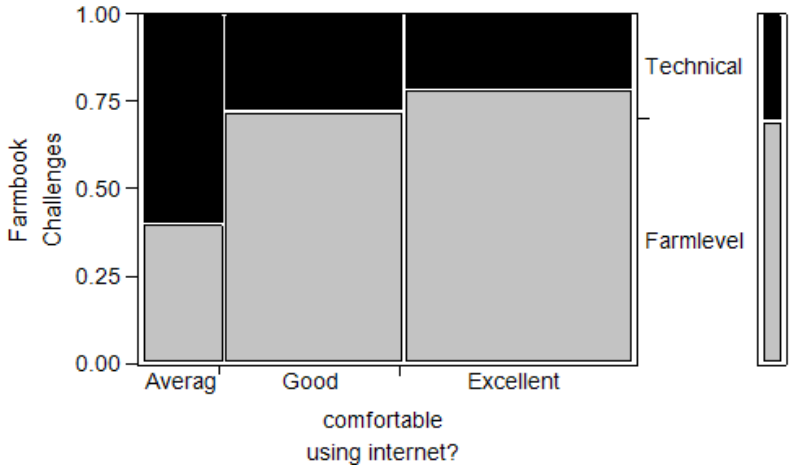

Figure 5. Challenges to using Farmbook and ability to use the Internet.

3.7. Relationship between Farmbook Challenges and Internet Access in the Field

Figure 6 shows that extension agents with Internet access in the field had the smallest ratio of agents (9%) reporting technical challenges in the use of Farmbook. Among those with no Internet access in the field 50% reported experiencing technical challenges in the use of Farmbook. Thus, Internet access is crucial for successful adoption of Farmbook.

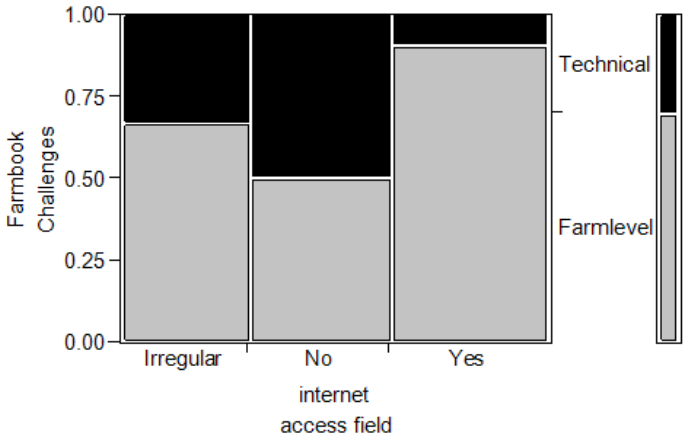

Figure 6. Challenges to using Farmbook and Internet access in the field.

4. Conclusions

Farmbook is an innovation that can be used to substitute the traditional manual, costly, and time consuming business planning methods currently used by extension agents in developing countries. Farmbook allows extension agents to register people into households, register farmers into farmer groups, enables farmers to run profitability analyses for specific products, enables farmer groups to develop business plans, supports crop production scheduling and allows field agents to record farm visits, training and assets transferred.

In addition, the application provides farmers with access to a business planning software that is focused on improving their product and market opportunity, and helping them access credits. It provides customized business plans that can help individual farmers analyze farm preparation costs, type and cost of investment loans, sales, revenues and profits.

The null hypothesis that guided this study was that socio-economic factors have no impact on the challenges faced by extension agents using Farmbook. Our results have however shown that socio-economic factors including gender, age, educational qualification and Internet access have an impact on challenges faced by extension agents using Farmbook. These results correspond with Mwombe *et al.*'s [9] findings that socio-economic factors like age, gender, income and acreage of bananas planted had an influence on the intensity of use of ICT tools as a source of agricultural information for smallholder banana farmers in Gatanga district, Kenya. The results also support the conclusion that social and economic factors are important variables in the diffusion of agricultural innovation.

Our finding show that extension officers with advanced degrees faced less technical challenges using Farmbook than their less-educated colleagues. This finding underscores the need for professional development and capacity building of officers lacking advanced degrees. Government role should include raising educational levels of staff and increasing opportunities to pursue advanced degrees for both men and women extension staff. This emphasizes the need for in-service and on the job training and capacity building in the use of ICTs for extension officers. The highly educated extension staff could be trained on the more sophisticated aspects of the Farmbook technology so that they can fulfil the role of providing technical support to the others. This would have the long-term benefit of ensuring that the technology becomes locally owned, thus enhancing sustainability of this agricultural extension approach.

A second finding from our analyses worth flagging up is that survey participants with Internet access in the field and who were proficient at using the Internet experienced fewer challenges using Farmbook compared to their colleagues who had no Internet access in the field and who were not proficient in their use of the Internet. Government policies towards improved infrastructure and access

to Internet and other mobile communication technologies for rural people would improve the overall use of Farmbook and other ICTs [23].

Another role of government and the international community should be to increase awareness of ICTs including Farmbook and integrate such technologies for use within government extension programs. In addition, both the public and private sectors should work together to support further ICT development and applications like Farmbook.

No innovation is without drawbacks—thus some of the limitations of the technology are as follows: both extension agents and farmers need to be included in further improvement of the technology and developing content for Farmbook. Farmers will find it more beneficial in some cases if it is in their local languages. There is also a need to have a team on the ground to resolve technical problems as soon as they arise rather than out-sourcing problem solving to experts based abroad. Lastly, there is also a need to empower in-country nationals to own the technology.

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