Innovative Information Diffusion to and Among Farmers

Challenges and Prospects -A Review

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Abstract

In this paper, the author reviewed several empirical research studies targeted towards understanding the processes by which innovative information diffuses to and among farmers and the potential impact of such diffusion. The challenges and prospects in the information diffusion process as described by the authors were clearly articulated to provide a blue print for policy makers and other stake holders in the industry to identify hurdles to innovative information diffusion and their possible solutions. The potential of mobile phones (waiting to be exploited) in enhancing the diffusion process is also highlighted. A road map that facilitates the establishment of an efficient mobile phone based farm information diffusion structure in Nigeria was developed. This review provides information that will facilitate easy selection of the best farm management practices which will enhance information transfer to and among farmers for improved production agriculture, environmental quality and agricultural health and safety. Target intervention programs can thus be appropriately channeled to farmers through paths of least resistance to information diffusion.

Keywords

Information Diffusion; Innovation; Mobile Phones; Farmers; Challenges; Prospects

Introduction

Innovative farm Information diffusion is a subject that has received much attention in a variety of professional disciplines over the past few decades (Feder and Savastano, 2006). According to Feder and Savastano (2006), researchers have proposed various theories on the factors and processes which underpin the observed patterns of information diffusion and the adoption of innovations. This interest emanates from the fact that adoption of better innovative technologies, organizations and contractual arrangements have direct impact on improving the well-being of societies and the environment we live.

The term "adoption" refers to the process that an individual passes through since he or she first hears of an innovation until it starts to be used on a continuous basis (Rogers, 1962). Adoption is the outcome of a dynamic decision-making process that includes learning about the technology through the collection of information or the experimentation (Feder et al. 1985). There is a distinction between an individual farmer adopting an innovation and the aggregate adoption or diffusion of the information among several farmers. The level of adoption was defined by Feder et al (1985) as the degree or intensity with which a new technology is used when the farmer has complete information about it. Such intensity can be measured as the amount of use of that technology or as whether the farmer uses or does not use the technology.

Farmers have several processes by which they access, evaluate and use information to make production and management decisions. According to Boone et al. (2000) these processes have been studied extensively for more than 80 years. Before the year 1950, most agricultural communications research focused on conveying new innovative information generated from established Colleges of Agriculture to farmers (Tucker and Napier, 2002). This trend began to change due to the rapid growth of the use of various communication media to convey agricultural information to farmers in the 1950s. According to Evans and Salcedo; (1974), an increasingly competitive media environment was created, which resulted in a strong demand for marketing and demographic research to target farm and consumer audiences.

Today, farmers have multiple channels to relevant information due to extensive public and private sector efforts made to enhance the communications industry. Farmers can now access farm information through farm magazines, technical publications, general interest magazines and newspapers, radio and television, the internet and other computer based

electronic data base and lastly the mobile phones (introduced by the author considered to have huge potentials for innovative farm information diffusion waiting to be exploited). In most developing nations such as Nigeria, majority of the farmers do not have access to several of these communication mediums. Due to the wide campaign and continuous expansion of the telecommunications industry in Nigeria which has provided wider coverage even in several rural communities (Onwuemele, 2011), the use of mobile phones can be considered to have the potential to deliver relevant, innovative and useful farm information to farmers at much reduced costs.

Information about farmers' communication and information-seeking behaviours has been shown to be useful for understanding the needs of client groups and to target intervention programs (Tucker and Napier, 2002). A better understanding of the processes by which new knowledge diffuses within and across societies and communities can suggest actions and investments that can be undertaken by governments and firms with the aim to promote innovations (Feder and Savastano, 2006). This will assist in planning and administering educational programs related to production agriculture, environmental quality, and agricultural health and safety (Tucker and Napier, 2002).

In this paper, the author gives a review of several researches targeted towards understanding the processes by which innovative farm information diffuses to and among farmers and the potential impact of such diffusion. The challenges and prospects in the information diffusion process as identified by the authors of the papers reviewed are also clearly articulated to provide a blue print for policy makers and other stake holders in the industry to identify hurdles to innovative information diffusion as well as the suggested solutions. The potential of mobile phones (waiting to be exploited) in enhancing this diffusion process as well as a structural plan to exploit this potential is also presented.

Previous Empirical Studies on Information Diffusion among Farmers

In this section, a review of several researches spanning over five decades carried out by several authors on information diffusion among and to farmers is presented. In each paper reviewed, the notable challenges to information diffusion and their prospects identified by the authors are highlighted.

Calatrava and Franco, (2011) carried out an analysis of the adoption and process of diffusion using pruning residues as mulch in Southern Spain olive orchards. They investigated both the time path of the diffusion of the use of this practice among farmers, and the factors that determined its adoption on a regular basis by many farmers in the area. Their work was built upon that of Calatrava et al. (2007), to widen and complete their analysis using data from a recent and more exhaustive survey.

They stated that using vegetation residues as mulch allows controlling erosion, conserving water resources, improving nutrient recycling and the efficiency of humification processes, and providing an import source of carbon for soils (Xiloyannis et al., 2008). The initial tradition is to burn these residues, a practice which may cause damage to trees, emit CO_2 into the atmosphere, add global warming effect and may lead to wild fire. The use of pruning residues is not expensive unlike mulching using artificial materials. Another advantage is that the residues remain for a long time in the soil, reducing weed growing and the application of herbicides. Thus, soil and nutrient loss is reduced. The main drawbacks of this practice are that special machinery is required to grind the residues and that pruning must be done every year (Xiloyannis et al., 2008).

They identified the following factors as influential to the decision of farmers to adopt new innovative technologies and practices:

Access to information about the innovation through exposure to sources of information which will accelerate its adoption by making individuals aware of the objective potential benefits of the technology.

The existence of economic barriers such as the limited access to production factors such as land, capital, etc. which can negatively affect adoption.

The process of both disseminating information and providing financial incentives which will encourage adoption.

The farmer's perception of the technology claims when compared with traditional methods.

The location of the farm (hillside, steep slopes or level land) and the level of soil conservation required.

The level of education and professionalism of the farmer. More professional, well-informed and innovative farmers are more likely to adopt this practice.

Probability of continuation of farming by a relative in

the future which will influence the willingness of the farmer to accept or reject new conservative farm practices due to cost.

Their study showed that mulch using the grinded pruning residues has been practiced by nearly 43% of surveyed farmers and is far more popular than the use of vegetation covers or strip. Their results suggested that the diffusion process of this practice is based on the interactions among farmers in the area rather than external factors such as EU subsidies or extension services. Farmers rely mostly on other farmers and technical advisors from agricultural cooperatives to solve problems in their farms.

Farm size and farmers' age are not found to be relevant to the adoption of this practice in this study. They could not directly compare their results with other works because, according to them, no previous study has analysed the adoption of mulch using the grinded pruning residues.

Some policy interventions suggested by them to foster the adoption of soil conservation practices based on the factors identified include:

Policies encouraging generational relief which will make the new generations want to continue with their farms hence farmers will be more ready to adopt the innovation due to its positive long term effect.

Farmer's technical education and more professionalized farm management which are likely to have an impact on the adoption of the practice.

Increase in the effectiveness of subsidies to environmentally-sound farming practices through farmers' formation and awareness about the different technical options available for soil conservation, as well as about the benefits of this and other practices.

Heong et al. (1998) investigated the use of communication media in changing rice farmer's pest management in the Mekong Delta, Vietnam. According to them, most Asian rice farmers adopted pesticides as their main pest control tactics which they used more frequently than herbicides and fungicides They also stated that in many reported cases, these insecticide applications are unnecessary and unlikely to yield economic returns because they were often introduced at the wrong time and directed at the wrongtarget. Heong et al. (1998) decided to use the mass media to evaluate the use of communication media (perceived to be the most rapid and efficient means of diffusion of innovation (Rogers, 1995) to motivate the farmers to change their perceptions and practices related to pest management in general and leaf folder control in particular. They targeted the rice farmer's beliefs, attitudes and practices in spraying against leaf-feeding insects. A workshop with participants from research extension and agricultural communications was conducted in Vietnam to develop media materials that will motivate farmers to evaluate the heuristic: 'Spraying insecticides for leaf folder control in the first 40 days after sowing is not needed'. They developed several versions of leaflets, posters and radio dramas which were designed to provide information on both innovation and the consequences of the innovation which were widely distributed using several channels for one farm season.

Their findings showed that Farmers in the study sites were motivated to reduce their insecticide spraying by 47% and from 3.35 to 1.76 sprays per season. This reduction seems to be attributed to the change in beliefs of the rice farmers as indicated by the reduction in the belief index from 11.3 to 7.6. The direct relationship between number sprays and the belief index further supported this conclusion. They reported a reduction in the farmers spraying in the early crop stages (from 60% to 25%), late tilling stages (form 82% to 41%) and the booting stages (from 84% to 55%) eighteen months after the mass media campaign, and observed a further reduction from 60% to 0% for farmers spraying in the early crop stages, 82% to 19% for farmers spraying in the tilling stages and from 84% to 31% for farmers spraying in the booting stages thirty one months after the introduction of the campaign.

The mass media campaign was designed to reduce only the early spraying, hence some farmers did not have information on whether their crops will be affected; hence they returned to spraying at the later stages.

The massive changes in the farmers' attitude and practices after the mass media campaign showed that the farmers' perceptions of the damage to the crops rather than the economic rational determined their initial decision to use pesticides. The motivation of the farmers to adopt the innovation depended on the savings in chemicals and labour cost as well as the fact that the innovation could be tested. These benefits were emphasized by the campaign. It is therefore necessary that programmes targeted to change farmers' perceptions be designed with these characteristics.

The Post-test survey of the twelve district showed that

82% of the farmers' household have been reached and many ceased their insecticide spraying for leaf crop folding in the early stages. Heong etal (1998) suggested the need to repeat the campaigns at intervals to sustain the adoption of the innovation but the innovative information may be presented using a different approach.

Feder and Savastano (2006) investigated the role, characteristics and impact of opinion leaders on the diffusion of new knowledge, using the case of Integrated Pest Management (IPM), and considered the extent to which the attributes (social status, wealth, skills) that make opinion leaders stand out in a community can hamper or enhance their ability to disseminate information to an audience who is of a lesser status, lesser wealth, and lesser skills.

According to Roger (1995), opinion leaders are individuals who have the status, expertise, links to external sources of knowledge, or experience that enable them to provide information and advice about innovations to others within their community. Such leadership may be informal rather than formal, but many scholars have observed that opinion leaders tend to have higher social status than ''followers'' (Bandura, 1986). They considered some factors in selecting IPM trainees who will fuction as opinion leaders:

1. Total rice land owned in 1991 which is an indicator of wealth, and related to status.
2. Spending on pesticide per hectare of rice in 1991 (measured in natural logarithm) related to wealth, as well asthe potential interest in IPM.
3. Rice yield per hectare in 1991 (measured in natural logarithm) taken as an indicator related to farming skills.
4. Education of household head in 1991 which positively affect their productivity.
5. The highest education level in the household in 1991 since families with more highly educated members are typically of higher status even if the selected farmer himself is not the most educated in the household.
6. Score on knowledge of IPM in 1991 since the level of familiarity with IPM concepts is an indicator of a farmer's knowledge and skill in farming.
7. Area of unirrigated rice land owned in 1991.
8. Number of household members in 1991. Large households imply lower land per person and thus less wealth per capita and lower status.

Factors 1 to 6 will have increase in the probability of selection whereas factors 7 and 8 will have a decrease in the probability of selection.

They included additional sets of variables, which can characterize the access to other sources of information, and are defined at the village (rather than individual) level including the following: The number of sales kiosks in the village in 1991, whether there is an active agricultural cooperative in the village in 1991, the change in travel time to sub-district townships between 1991–1999, the change in availability of pest observers in the village and lastly the change in the extent of village irrigation. The farmers were divided into two groups: the early trained and those who were trained later.

Their findings showed that the effectiveness of opinion leaders in diffusing knowledge that was specifically targeted to them through intensive training depended positively on the extent of leaders' superiority compared to the socioeconomic and farming skill attributes of the would-be followers. However, the results indicated that if the selected opinion leaders are excessively superior to the others in the community, their effectiveness actually diminishes and they may become essentially irrelevant to the diffusion of knowledge beyond a small circle of those higher status individuals who are closely associated with them.

They noted that these conclusions have implications for the operations of extension and information programs seeking to spread new knowledge widely across large populations, particularly in areas where mass media sources are not accessible to the majority of the population. Such programs have traditionally focused on the direct interactions of change agents (extension workers, trainers) on selected individuals, as budget and manpower constraints would not allow for direct interaction with every member of the target population. As evident from the results of their analysis, it is possible to err in two opposite directions:

(i) Selecting diffusion agents who are too ''average'' to the point that they are not much respected as leaders, and

(ii) Selecting opinion leaders who are too prominent and have gained a high social status which limits their interaction with most members of the community, hence the community members may view their knowledge as irrelevance.

This challenge can be overcome if the community members participate actively in the selection process

of opinion leaders since some of the traits that are not readily observed by outsiders and researchers are often known to members of the communities involved.

Feder and Savastano (2006) noted that for political reasons, there are circumstances where programs include representatives of the latter group which should not be excessive. Similarly, there may be circumstances where lower-status members of the community who are not currently opinion leaders should be included for purposes of empowerment and development of their potential leadership capacity rather than diffusion of information.

Lionberger (1954b) investigated the relation of informal social groups to the diffusion of farm information in a North East Missouri farm community and some characteristics of farm operators sought as sources of farm information in a Missouri community. In the studies, the characteristics considered are as follows: Age and experience, Educational attainment, Participation in formal social groups, Social economic status not influenced by personal achievements and that based on personal achievements and lastly Symbols of mass societal status.

Formal social groups may be localised within a community (local farm clubs) or between communities. Those social groups that are functional between communities are usually administrative or advisory in nature and specially designed to promote special interests. Information is easier to transfer when both the information seeker and the one sought are members of the same social group.

Their data analysis revealed that those who were sought as sources of information had some characteristics which distinguished them from other farm operators in the community. These characteristics were also seen to be functionally related to the diffusion and use of farm information. In the analysis, age, experience and educational attainment, did not have much effect on whether opinion leaders will be sought for farm practice information or not.

Participation in formal social groups was seen to be related to both social standing in the community and the diffusion and use of farm information. The attributes of formal social groups which are likely to bear such a relationship are: how expensive are the association patterns and the degree of secularization patterns manifested in group objectives and activities.

Under Symbols of mass societal status, ownership of personal farms, size of the operations, subscription to newspapers journals and magazines, exercise of administrative and advisory responsibility through Formal Social groups, community prestige, technological competence, other institutionalised symbols of status e.g. availability of electricity in homes, ownership of telephones in homes, radios, tractors, etc. were all found to have direct influence on whether they will be sought for farm practice information or not.

The opinion leaders referred to as "local influentials" were seen as "low resistance avenues" or paths through which farm information can be channelled to other farm operators because of their receptivity to new ideas about farming and their positions in the informal social structure.

The challenge is how to identify these local influentials and make them involved in strategic programmes targeted towards enhancing diffusion of information among farmers aimed at promoting safer and more productive practices. The characteristics identified in this work by Lionberger (1954a) can be used as a guide (although not conclusively so for every community) to identify local influentials.

Wyckhuys and O'neil (2007) investigated the role of opinion leadership, social connectedness and information sources in the diffusion of IPM in Honduran subsistence maize agriculture, and assessed the composition of farmers' social networks and their importance in IPM diffusion. The role of opinion leadership and the influence of pest management information sources in affecting the spread of IPM-related information were also determined.

According to them, farmers identified six sources of pest management information: personal experience, friends or relatives, outreach agencies, pesticide sellers, extension officers and radio. The number of insect natural enemies farmers knew depended on the pest management information sources they consulted outside their respective communities. Information on pesticide alternatives for management of a key maize pest, the fall armyworm *Spodoptera frugiperda Smith*, was gained mainly through interpersonal communication channels.

Their findings showed that IPM training recipients (opinion leaders) were socially well connected and up to 60% of them were consulted by their peers. Farmers connected to training recipients had a better appreciation of arthropod natural enemies and, in certain communities, knew more about pesticide

alternatives and natural enemy conservation methods. A farmer has to be socially connected directly or indirectly to a trained IPM recipient to gain appreciable knowledge on IPM strategies. Just being socially connected is not enough.

Information on certain technologies (i.e. manual control, sugar-water application to attract arthropod predators) was shared among farmers, while knowledge of others (i.e. botanical insecticides) was largely restricted to training recipients. In communities that were socially well organized and frequented by outreach agencies, selected information appeared to diffuse beyond trained farmers.

Their results suggested that the farmers consulted by their peers for information or advice, could not only validate IPM practices under local agro-ecological conditions but can also facilitate widespread adoption of suitable technologies. Intensifying face to face interaction and highly interwoven social networks can also enhance the diffusion of agricultural innovations, such as IPM.

It is noted that successful adoption of IPM technologies that target those natural enemies is highly information dependent, requiring a fair amount of learning by farmers and largely based upon their appreciation of agro-ecological concepts such as biological control which can be a challenge in the diffusion process.

The study characterized opinion leaders, identified appropriate pest management information sources, suggested the importance of strengthening local social capital and therefore it could be crucial in successfully defining future IPM extension programs for the region's subsistence sector.

Tucker and Napier (2001) investigated preferred sources and channels of soil and water conservation information among farmers in three midwestern US watersheds. According to them, sources (government agencies, cooperative extension, and other farmers) provide the content or expertise of interest to the information seeker, while channels (magazines, radio, and the Internet, GSM phones) refer to the methods or vehicles by which information is transferred or received.

Their work was guided by the diffusion theory, Risk communication theory and the Farm structure theory. They collected data from 1011 primary farm operators within three midwestern watersheds located in Ohio, Iowa, and Minnesota. The study watersheds ranged in size from approximately 141, 700 ha (350,000 acres) for the Ohio watershed to more than 566,800 ha (1.4 million acres) for the Minnesota watershed. Data were collected using a structured questionnaire that addressed farmers' use of various information sources as well as preferred information channels to receive agricultural information. The questionnaire also requested information on farmers' perceived level of risk for specific aspects of agricultural chemical usage in the watershed as well as a variety of demographic characteristics.

The diffusion component of the study asserts that individuals actively seek information through a range of communication sources and channels to assess costs and benefits before making an adoption decision. The sources of information considered are Farm Service Agency, Agri-chemical dealer, Natural Resources, Conservation Service, Other farmers, Farm implement dealers, Friends, Farm cooperatives, Neighbours, Close family member, Cooperative Extension, Financial institutions, Grain elevator operator, Soil conservation districts, Department of Natural Resources, Hired consultants, University agricultural programs, Mass media, Local watershed alliance, Local conservation club, Nature Conservancy, US Geologic Survey and Environmental Protection Agency. However, in their analysis, six overarching groups of information sources (Agribusiness Sources, Agricultural Agency Sources, Agricultural-interpersonal Sources, Conservation Organization Sources, Environmental Agency Sources, and Extension Sources) are derived from the 22 variables as important providers of conservation information.

Eleven information channels were identified: radio, television, online or electronic information available on a fee basis, online or electronic information available at no cost, farm magazines, technical publications, CD-ROM computer software, demonstration farms, on-farm tours, farm shows, and classes. Respondents were asked to rank the top three channels based on their perceived importance to receive agricultural information.

Their findings indicated that respondents in the three watersheds used a variety of sources for soil and water conservation information. Government agencies and agricultural chemical dealers were shown to be the most frequently used sources, and that the infrequent use of extension services is an indication that the agency may be losing clientele to other public- and private-sector sources of information. They observed variability of sources used within the study area which indicated that farm audiences may differ considerably

even within relatively small geographic areas. Information directors should therefore think in terms of selective targeting of smaller, specific segments of the farm population which will make them more likely to be more successful.

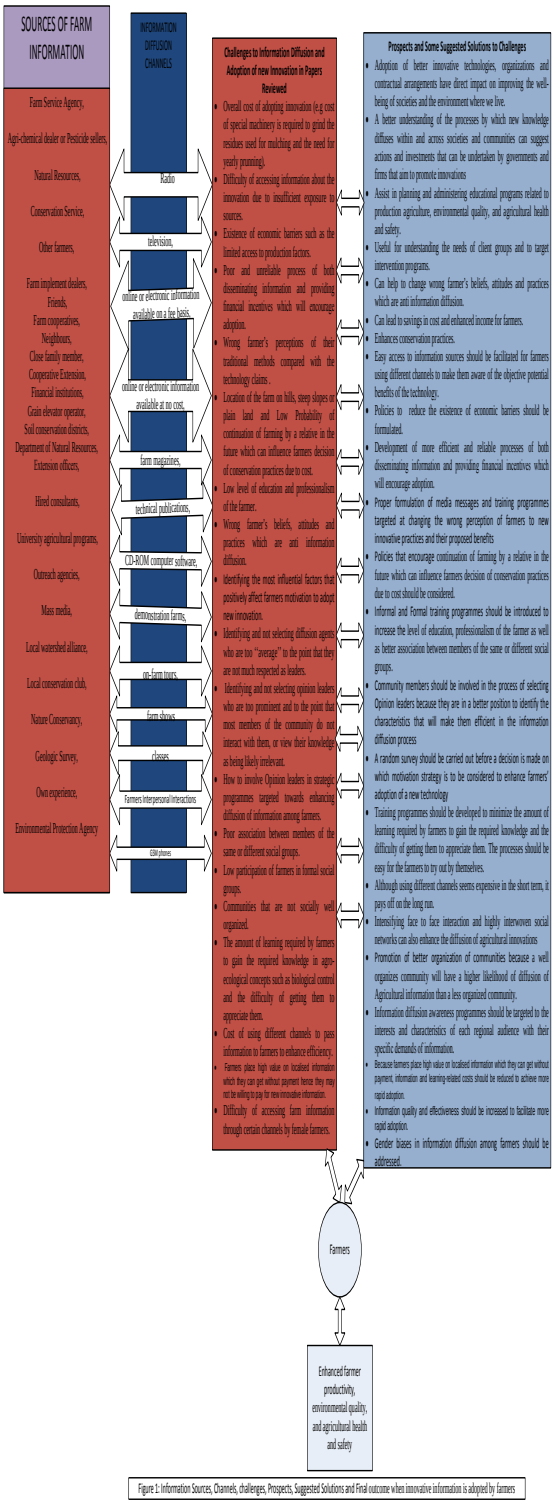

Figure 1: Information Sources, Channels, challenges, Prospects, Suggested Solutions and Final outcome when innovative information is adopted by farmers

Their results showed that farm magazines are the preferred channels to receive agricultural information across the three watersheds.

They suggested that Managers of conservation information and educational programs can improve efficiency and extend their reach to farmers by including these six overarching groups of information sources which they have identified in future communication programs. Communication managers should incorporate a wide range of information channels into their outreach efforts, including interpersonal methods, traditional mass media and emerging online technologies.

They suggested that channels should not only be selected and evaluated strictly on their capacity to reach large numbers of farmers, but also based on their perceived credibility and relevance among target audiences.

Information diffusion to and among farmers was also studied by Villamil, et al. (2008), Heffernan et al. (2008), Llewellyn, (2007), Lichtenberg and Zimmerman (1999), Reddy, (2008). Katungi et al., (2008), Leckie, (1996) and Liang, (2012). The review findings are clearly articulated in Figure 1 which shows information sources, the challenges, prospects, suggested solutions and final outcome when innovative information is adopted by farmers.

Having considered the empirical findings of several authors on information diffusion to and among farmers, it is believed that mobile phones have the potential and can be used as an organ of the media to deliver information to farmers as well as support its diffusion.

The Potential of Mobile Phones Waiting to Be Exploited in Innovative Farm Information Diffusion in Nigeria.

The introduction of mobile phones (whether GSM or CDMA technology based) has greatly enhanced information access for the general public both here in Nigeria and other countries of the world (Onwuemele, 2011; Adewale and Falaki, 2003; Anyasi and Yesufu, 2007; Ajala, 2005). This could be information transfer among family members, farmers, friends, religious and secular social groups, the government and their various agencies, etc. Nigerians in particular can testify the fact that the diffusion of the mobile phones in the country has greatly enhanced their access to information and has helped them to make huge savings in time, travel cost, quick conclusion of business deals and other valuable resources.

Today in Nigeria, the telecommunications companies have continued to expand their coverage, hence many rural communities, especially those along main roads,

have access to mobile phone service (Onwuemele, 2011), consequently mobile phones have reached 80% of the populace (Iroko, 2012). With the continuous competition among the telecommunications providers in Nigeria, the cost of owning and maintaining a mobile phone has continued to decrease; hence many Nigerians can now afford to own their personal mobile phone. Among those in the rural communities, this situation is not much different because their relatives who live in urban communities often help to acquire this valuable equipment for their relatives so that they can continue to communicate with them.

It is indicated that this diffusion of mobile phones all over the country has the potential to deliver innovative farm information to farmers both in the rural and urban communities. Currently, mobile phone technologies (GSM or CDMA) have some key features which support the large scale distribution of information (paging). Anyone who uses a mobile phone will attest to the fact that they receive unsolicited messages on a regular basis. These messages are either from the telecommunications service providers themselves or others who have identified this huge potential of the mobile phone technology and have taken advantage of it to sell their products and services. These messages can be either voice messages in any language or data (text messages). The mobile phone based technologies (GSM or CDMA) have the potential to deliver to every farmer who has a phone any innovative farm information that will be relevant to help them adopt the new innovation at any time.

The questions that need to be answered are: Where are we and where do we begin? How best can this huge potential be used efficiently to deliver innovative farm information to farmers? How do we acquire the data base of the farmers' phone numbers? How do we deliver this information in a manner that the farmers can understand them and will be willing to change their traditional practices? How do we create such innovative information in the appropriate electronic and easy to understand formats and in different Nigerian languages before transmitting them to the farmers? How do we establish a link between researchers who come up with this innovation and the farmers? How do we establish an efficient mobile phone based information diffusion structure that will reach the nook and crannies of the nation? What roles will the Government institutions, Traditional rulers, researchers and other Agricultural extension service workers play in this diffusion process? What role will the telecommunications service providers play in the process? What role will the farmers and their organized associations play in this process?

Some answers are available to the aforementioned questions in this paper.

The Strategies to be Employed in Using Mobile Phones for Farm Information Diffusion

Nigeria as a nation already has a large tele-communication infrastructure base which is continuing to increase. The mobile phone based technology has already supported applications that can distribute information (whether voice or data in any language) to a large number of subscribers. The most difficult challenge is how to acquire the farmers' phone number data base. The following steps are recommended to efficiently deliver innovative farm information to farmers using mobile phones:

The Federal, State and Local Government ministries of Agriculture in collaboration with the Ministries of Information and Communications and the Nigerian Communications Commission (NCC) should set up a joint agency that will act as a backbone to pursue the establishment of an efficient mobile phone based farm information diffusion structure that will reach the nook and crannies of the nation.

On the request of the agency, all mobile phone service providers should provide the information of their registered phone users especially those in rural communities. With the on-going SIM registration process (Juwah, 2012), this goal will be easy to achieve.

The agency in collaboration with Mobile phone service providers should also consistently send paging messages in English and several local Nigerian languages to all their subscribers requesting that all farmers (animal or crop) should provide information on the Local government area where they live and where their farms are located and the type of farms they have through their personal phones to selected and toll free phone numbers from each mobile service provider. The farmers will be encouraged to visit their local government headquarters for additional information if the need arises. The paging messages sent to the farmers should state the reason for the registration which is free distribution of innovative farm information to farmers who register. This will act as a motivation to the farmers.

Other media avenues, traditional rulers, farmers associations, farmers cooperative societies, religious leaders, etc., will also be used to pass the information requesting farmers to send their information through

their personal phones to the required numbers. Online registrations should also be provided as an alternative. This process of farmers' phone number registration will be continuous even after the initial deadline expires so that new farmers can also send their information to the agency. The data base to be acquired will also contain information of other stake holders (Traditional rulers, Religious leaders, Agricultural extension workers, Farmers association executives, Executives of farmers' cooperative societies, Agricultural Research Institution and Universities' unit heads, etc.) involved in the diffusion process.

The agency will collate relevant information on innovative farm practices already being used both locally and internationally and will collaborate with research institutes, universities and other relevant sources in gathering this information.

New and proven innovative findings in research institutes and universities will be forwarded to the agencies for onward forwarding to farmers through their registered phones. A reward, which may not be monetary, will be given to researchers who develop and bring innovative methods and technologies for farmers.

The media will be engaged to develop short audio and video dramas used to communicate the new innovation to the farmers in an easy to understand format and in several languages. Data or text messaging will also be developed.

Information on the new innovation, weather forecast, farm seasons, available extension services, etc. will be forwarded to farmers on a regular basis. To avoid congestion of the telecommunications network, this information will be forwarded during off peak periods. For voice information, farmers will be notified about the off peak timing so that they can be alert to receiving the necessary information.

The Federal, State and Local Governments are to provide visible support to the agency using the media so that all parties concerned will be willing to cooperate with the agency and practice their required roles.

The agency will work hand in hand with agricultural extension workers so as to provide additional support information to the farmers. These agricultural extension workers will also be supplied with information on new innovation through their phones by the agency.

Every Local government will have a unit under their ministry of agriculture which will collaborate with the agency to ensure their smooth operation in the Local government area.

The agency after developing the audio, video and text messages in collaboration with the media will page them to the farmers in collaboration with the Mobile service providers. The farmers will receive direct farm information in their phones from the Agency through the telecommunications service providers.

Farmers will be provided with toll free phone numbers to which they can deliver feedback information to the agency that will be forwarded to appropriate destination for prompt action. Codes will be developed which farmers can send to request for a particular farm information and responses which are software based can be automatically generated to send the requested information to the farmer.

The developed structure to deliver innovative information to farmers using Mobile phones as the main channel is shown in figure 2.

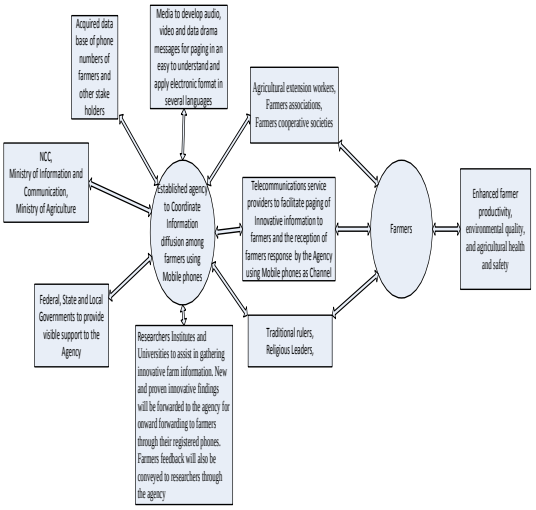

Figure 2.Developed Structure to Deliver Innovative Information to Farmers using Mobile phones as the main channel

When the above described structure is in place, all kinds of farm information can easily be delivered to the farmers directly at a much reduced cost. Feedback from farmers will also be facilitated using a toll free number. The review carried out has shown that the media is the most influential on farmers' perception of new innovation (Heong et al., 1998; Roger, 1995). The use of Mobile phones as an organ of the media through sending of paging messages will do just the same. It will be very economic once the data base of farmers' phone numbers has been acquired. The few farmers who may not have the privilege of getting the new innovation directly will be exposed to it through their interpersonal relationships with other farmers in

their location. With slight adjustment, this structure developed can be used to diffuse any form of information to a target audience.

Conclusion

In this paper, the author reviewed several empirical works on the diffusion of innovative farm information among farmers. The impacts of such diffusion and the challenges and prospects as well as suggested solutions in the information diffusion process were also clearly articulated. This will provide a blue print for policy makers and other stake holders in the industry to identify hurdles to innovative farm information diffusion and make the suggested adjustments to their programmes. Target intervention programs can be appropriately channelled to avoid hurdles identified.

The potential of Mobile phones (waiting to be exploited) in enhancing this diffusion process in Nigeria was clearly articulated in this paper. A road map that will facilitate the establishment of an efficient Mobile phone based information diffusion structure reaching the nook and crannies of the nation was developed.

This review has provided information that will enhance easy selection of the best farm information management practices which will help to facilitate information transfer to and among farmers and the subsequent adoption of innovative technologies for improved production agriculture, environmental quality, and agricultural health and safety.

ACKNOWLEDGEMENT

The author acknowledges Professor S. O. Owa and Dr Osemwengie O.O. for their useful suggestions that have enhanced the final outcome of this review.

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