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RESEARCH ARTICLE :

Cyber extension for better nutritional security: Some developments and perspectives

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SUMMARY : India registered remarkable economic growth during the first decade of this millennium. Ironically, during this period, a vast section of population remained undernourished. The annual economic losses associated with malnutrition have been estimated at 3 per cent of India's gross domestic product (GDP). Experience shown that increasing food production alone cannot address the issue of malnutrition, unless there is a nutrition focus and the poorest have access to a source of diversified and nutritious foods. Knowledge and information are important factors to ensure food and nutrition security. The problem of malnutrition can be better addressed through a innovative ICT led extension systems. Rapid advances in data acquisition and management, modeling, computation power, and information technology provide the opportunity to harness this knowledge in new and powerful ways to achieve more productive and sustainable agricultural systems. Examples of this technology include mobile phones, social media, tablets, internet, email, global positioning systems (GPS) etc. In this paper we employ the use cases and our collective experiences with agricultural systems and Information and communication technology (ICT) to describe about data and knowledge products need to improve food security and better nutrition.

KEY WORDS :
Nutrition security, Mobile phones, GPS, Knowledge

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BACKGROUND AND OBJECTIVES

With the success of green revolution in India, agriculture has evolved from subsistence farming into a complex and profit oriented business, which requires accumulation and integration of knowledge and information from diverse sources. An increasing population coupled with mining of natural resources requires application of new technologies to maintain a sustainable food and water supply without environmental degradation.

It is essential to optimize the various inputs under different edapho-climatic and cropping system. Farmers need different calculated feasible, viable and economical practices to follow for better output and income. But existing extension is unable to provide timely demand based information to

the farmers. The extension personnel of the Department of Agriculture disseminated the technological messages to the farmers manually. This approach has not been able to reach majority of the farmers who are spread across the whole country. This gap remains a challenge for the extension system even today. Farmers' needs are much more diversified and the knowledge required to address them is beyond the capacity of the grass root level extension functionaries. Quick dissemination of technological information from the agricultural research system to the farmers and reporting of farmers' feedback to the research system is required in transfer of agricultural technology. The limitations in existing extension are 1. Traditional extension is expensive. 2. Traditional extension is more time and energy consuming processes. 3. Poor communication capacity of existing extension systems. 4. In traditional extension system the quantum of modification and missing in message is high. 5. The area /client coverage capacity of the traditional extension system is very limited. 6. Lack of extension personnel/experts in general and non-qualified and educated personnel in specific.7. There is lack of timely incorporation of new vision and ideas in existing extension system (Arulraj and Ravi Kumar, 2004). Today the above limitations in traditional extension system can be removed by using the potential of Information and communication technologies (ICT) to meet the location specific information needs of the farmers and describe the knowledge products need to improve food security and better nutrition.

RESOURCES AND METHODS

The information and communication technologies/ information and communication management (ICT/ICM) can offer immense opportunities to the farming communities in the rural areas to update their knowledge and bridge the gap between farmers and the researchers. We organize this paper as follows. First, we discuss about cyber extension tools available for effective dissemination of information and knowledge to farmers followed by successful stories on ICT/ICM in agriculture from five countries, *viz*., Bangladesh, India, Nepal, the Philippines and Sri Lanka.These success stories focus on a variety of ICT/ICM initiatives in agriculture that included innovative television program *Moti-O-Manush* in Bangladesh, ICT-enabled information services to farmers through *aAQUA* initiative in India, improving adoption of technologies and marketing in vegetables with the help of *Krishi Community Radio* in Nepal, appropriate use of ICT tools and methods through Farmers Information and Technology Services (FITS) in the Philippines, and Cyber Extension in support of agricultural extension system in Sri Lanka. These success stories highlight the role of ICT/ICM in strengthening the present agricultural extension system in the respective countries for efficient transfer of technologies to the farmers. This paper also covers case studies for effective knowledge sharing technologies for improving nutrition and food security of rural households.

OBSERVATIONS AND ANALYSIS

Dissemination of agricultural innovations and technologies plays a crucial role in taking the research results to resource poor smallholder farmers. The demand of farmers regarding knowledge on innovations and technologies has been growing in order to face the challenges posed by climate change, depleting natural resources, food security and safety, market opportunities and value addition etc. These problems can be overcome by using cyber extension tools available for effective dissemination of information and knowledge to farmers.

ICT and cyber extension :

The information and communication networks are expanding very fast in India. Modern communication technologies when applied to conditions in rural areas can help in improved communication, increased participation and also in dissemination of information and sharing of knowledge and skills. It is being said that "cyber extension" would be the major form of technology dissemination in the near future. Information and communication technologies (ICT) particularly the Internet, are transforming all human activities dependent on information, including rural development and food security.

Cyber extension terminology :

Cyber:

Cyber means, relating to "Information technology, the internet, virtual reality and the Cyber Space" (Sharma, 2003)

Cyber space:

The cyber space can be defined as the imaginary

space behind the interconnected telecommunications and computer networks, the virtual world. Software tools on networks provide facilities to interactively access the information from connected servers (Wijekoon and Newton, 1999).

Cyber extension:

Cyber extension thus can be defined as the "Extension over Cyber Space". As the word extension is subject-neutral, so is Cyber extension. But in the applied context of agriculture, Cyber extension means "using the power of online networks, computer communications and digital interactive multimedia to facilitate dissemination of agricultural technology". Cyber extension includes effective use of information and communication technology, national and international information Networks, Internet, Expert Systems, Multimedia Learning Systems and computer based training systems to improve information access to the farmers, Extension workers, and Research scientists and extension managers (Sharma, 2003). Important tools of cyber extension are E-mail, Telnet, FTP, Gopher, Archie, Veronica, Usenet Newsgroups, World wide web, Mobile phone. The ICTs can be classified into three groups:

New ICTs:

This group consists of computers, satellites, one-on-one connections, wireless phones (mobile), the internet, e-mail, the web, internet services, video conferences, CD-ROMs, personal computers (PC), distance control systems, informational-geographical systems, global positioning systems (GPS), electronic cameras, databases, etc.

Old ICTs:

This group consists of radios, televisions, telephones, telegraphs, audio and video cassettes, films and slides. This group of technologies has been used for several decades.

Very old ICTs:

This group of technologies has been used for several centuries and includes newspapers, books, photo albums, posters, theater, human interactions (Obayelu and Ogunlade, 2006).

According to Chowdhury (2001), ICTs play an important role in food security through facilitating accessibility to related policies and information for market communication, improving market profitability, helping farmers to make decisions, increasing diversity in rural economies and reducing the cost of living. Some of the success stories of ICT/ICM in agriculture are discussed below.

Success stories on ICT/ICM in agriculture from five countries:

aAQUA: ICT-enabled knowledge services to farmers in India :

The aAQUA which stands for almost All Questions Answered, evolved quickly into an online farmer knowledge exchange platform built by young agricultural extension staff (Malcolm and Attaluri, 2011). aAQUA (Fig. 1) is operational since December 2003 (Soumya, 2008) and demonstrates to farmers by variety of technologies that included mobile phones, website and SMS-based services jointly by the Developmental Informatics Lab of the Indian Institute of Technology-Bombay, Vigyan Ashram and KVK Baramati (NGOs) in Maharashtra.It allows members using a web browser on a computer to create, view and manage content in local languages (Hindi, Marathi and Kannada). On aAQUA, content is organized in the form of discussion fora based on the types of categories of queries posted by farmer or experts. There are 22 fora comprising 6 categories that included crops, animals, KVK

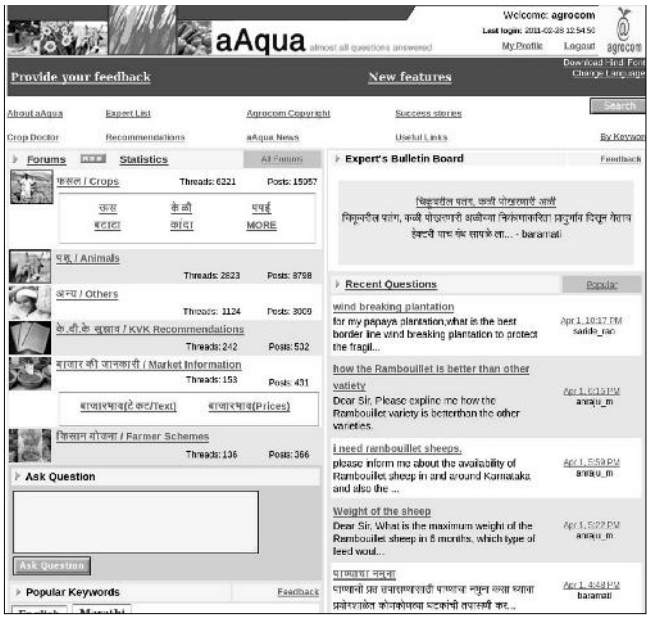

Fig. 1 : Home page of aAqua
Source : Malcolm and Attaluri (2011)

recommendations, farmer schemes and market information etc. The fora are open to all users for browsing without any charges for non commercial use (Malcolm and Attaluri, 2011).

The case of cyber extension: an ICT initiative for strengthening agricultural extension in Sri Lanka :

The Ministry of Agriculture through its audio visual centre has pioneered the implementation of Cyber extension initiative in a phased manner to strengthen extension in Sri Lanka in order to provide advisory services to farming communities in the rural areas. The Cyber extension approach uses the power of networks, computer communications and interactive multimedia to facilitate information sharing mechanism with revitalization of agricultural extension cadre and the personnel in the ministry (Malcolm and Attaluri, 2011).

In Phase-I, it employs the multimedia CD-ROM (Fig. 2) technologies for crop-based information, improving skills of extension workers, digital training material and distance learning for field level functionaries. In Phase-II, it exploited the telecommunication and web-based technologies to reach farmers and extension functionaries. Toll free telephone '1920' provides agricultural advisory services to farmers, information dissemination through Agro Technology Park (Fig. 3), creation of Wiki Goviya-Agricultural. Wikipedia, Agriculture Discussion Forum, Agricultural e-Learning

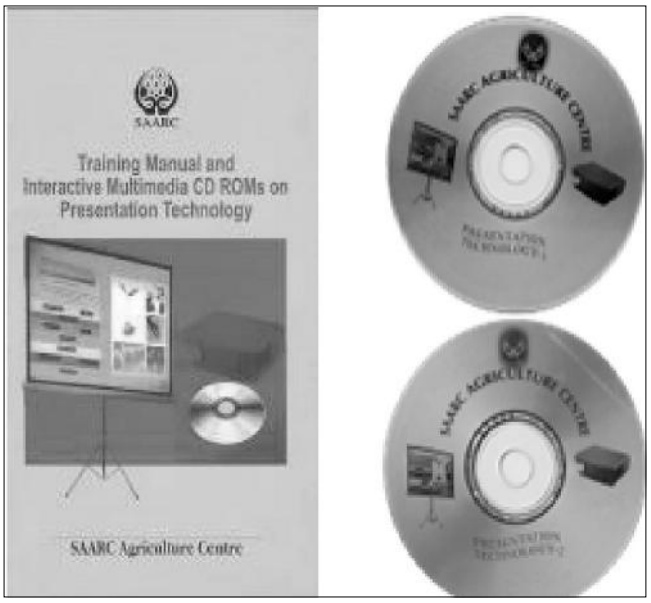

Fig. 2: Training mmanual and CD-ROM
Source : Wijekoon and Newton (1999)

Fig. 3 : Agro technology park at garnnoruwa
Source : Wijekoon and Newton (1999)

empowered the Cyber extension staff as well as farmers with latest and up-to-date information and knowledge. The impact of Cyber extension produced positive results and improved access to agrarian services centres and brought in responsibility among extension and other officers (Wijekoon and Newton, 1999). It provided opportunity to extension personnel to enhance their skills and knowledge to serve the farmers with latest and relevant information.

Empowering farmers through mass media: A success story of mati-o manush television programme in Bangladesh:

Mass media support to agricultural extension is important in any developing country especially when there are barriers like illiteracy and poor extension mechanism. The case of empowering farmers through mass media, A success story of *Mati-O-Manush* (Fig. 4) a television programme in Bangladesh shows how television has emerged as an important ICT initiative in transfer of technologies (Malcolm and Attaluri, 2011). The television programme, *Mati-O-Manush,* which means land and people, has become very popular means of dissemination of agricultural information on technologies, markets, farmers' innovations and non-farm activities in the rural areas of Bangladesh. The *Mati-O-Manush* programme gained popularity among farming community in Bangladesh for more than 30 years because of its focused and relevant content. The impacts of *Mati-O-Manush* programmes are significant in bridging the knowledge gaps in the smallholder resource poor farmers, farm women and youth who suffer from

poverty and illiteracy in the rural Bangladesh. It played important role in promoting homestead farming, rooftop cultivation, seed production and preservation, disease management in livestock, off-farm and non-farm opportunities especially for rural women.

Fig. 4: Mati-O-Manush programme on TV Source : Malcolm and Attaluri (2011) and www.btv.gov.bd

Impact of community radio on technology adoption and marketing efficiency of vegetable crops in Nepal :

The case of impact of community radio on technology adoption and marketing efficiency of vegetable crops in Nepal shows that communities take lead not only in addressing their immediate information needs through affordable ICTs but also manage the information centres on their own (Hussian, 2008). The case tries to capture the success story of Krishi radio stationed in Dharke (Fig. 5) and the Radio palung stationed in Palung in Nepal, which serve the vegetable farmers in the villages of the two districts. It provides i) Vegetable price information, ii) Technical problems and solution, iii) Organic farming, iv) Marketing of local produce, v) *Mela parma karyakram* (information on needs of *Khetala* (agricultural labour) which helps farmers to communicate with agricultural labour, vi) National and local news and the major headlines of national newspapers (UNESCO IPDC, 2008). Krishi radio played important role in providing suitable solutions to vegetable farmers for pest control, disease management, fertilizer management etc., besides raising farmers' voices on critical issues like input imports and market control. Community radio combined with modern information technology has been found very effective in bridging the digital gaps and help in the transfer of technology to the marginalized rural communities (Pringle and Subba, 2007).

Fig. 5: Krishi Radio Dharke (Source : Malcolm and Attaluri, 2011)

Fig. 6: Listening to radio (Source : Pringle and Subba, 2007)

Inter-farmers information and technology services (FITS) trading through information and communication technology in the Philippines:

Inter-Farmers Information and Technology Services (FITS) centres established in all over the Philippines. FITS centres provide farmers and researchers fast access to information and technologies and services in various multimedia formats, exhibits of new products and

technologies, Internet, SMS and FITS databases. FITS centres are supervised by the regional consortia. The FITS is a key role player to K-Agrinet's e-Farm, which focuses on the knowledge-based e-Commerce in the area. The case presents effective use of ICTs for trading planting material for the municipality of *Banga* with the active efforts by FITS Managers. The case demonstrates that knowledge workers play an important role in harnessing the ICTs for addressing the immediate needs in agricultural development. The FITS achieved remarkable results in actualization of K-Agrinet program, saving on purchases of planting materials, gender advocacy and social impact and bridging the last mile.

Case studies for effective knowledge sharing technologies for improving the food security/ accessibility of rural households:

The effective capabilities of information and communications technologies for improving the food accessibility were compiled:

The role of ICT in improving food accessibility of Iran's rural households:

To determine ICTs capabilities in improving food accessibility of Iran's rural households, total of 48 statements were used. The results indicate that most respondents (36.5%) assigned an important role to ICT capabilities in improving food accessibility of Iran's rural households (Table 1).

Table 1 : The role of ICT in improving food accessibility of Iran's rural households

Role	Frequency	Per cent	Cumulative per cent
Little	15	8.8	8.8
Medium	60	35.3	44.1
Much	62	36.5	80.6
Very much	33	19.4	100

Source: Farad (2012)

Marketing and distribution of agricultural produce:

One of the applications using ICT for agricultural marketing is Agmarknet which is discussed below:

Agmarknet: an agricultural marketing information system :

In India in order to provide an effective information exchange on market price, the Directorate of Marketing and Inspection, Department of Agriculture and Cooperation, Ministry of Agriculture, and the Agricultural Informatics Division, National Informatics Centre, Ministry of Communications and Information Technology, collaborated to create the Agricultural Marketing Information Network. The project aims at establishing an efficient nationwide system for the collection and dissemination of market information, and computerizing data on market fees, market charges, storage and modes of transportation (www.agmarknet.nic.in).

Community e-centres to improve agricultural productivity:

Rural access to ICT through community e-centres can be used to improve agricultural productivity by connecting the rural poor to direct markets, and by giving them ready access to information on the prices of inputs and products. In villages around Pondicherry, villagers operate local "knowledge centres", which are part of a network of telecentres established by the Swaminathan Foundation. These operators adapt data and information from public sources for their own weather bulletins, which they post on notice boards for the local fishermen. The telecentre also broadcasts appropriate information over loudspeakers, to benefit those who are illiterate, and publishes a local newsletter.

Another example is the e-Choupal model, established by a private Indian tobacco company. These telecentres are operated by ITC-trained local farmers, and provide the agricultural community with access to good practices in agriculture and market prices for commodities (http://telecentresap.org/meeting/cmap2007/India_Presentation_eChoupal.pdf).

Public-private partnerships in e-agriculture: stakeholder roles and incentives:

A public-private partnership is an initiative formed and operated jointly by a government or a public sector entity and one or more private sector companies, non-governmental organizations or civil society organizations. Some examples of public-private partnerships in Asia include the e-Choupal centres, Life Lines-India, Krishi Vigyan Kendra, and the Kisan Call Centres in India; the Commonwealth of Learning—supported Lifelong Learning for Farmers Project in various countries; the Grameenphone community information Centers in Bangladesh; and the e-Haat Bazaar in Nepal.

Use of innovative information and communication technology (ICT) for better nutrition:

India registered remarkable economic growth during the first decade of this millennium. Ironically, during this period, a vast section of population remained undernourished (Government of India, 2009). Levels of child underweight in India at 43 per cent are twice the average level of 21 per cent reported in sub-Saharan Africa; and stunting at 48 per cent is 8 per cent higher than that reported in sub-Saharan Africa (Das *et al.*, 2014).Malnutrition in all its forms imposes unacceptably high burden on society and contributed one-third to one half of child deaths (Government of India, 2009). The annual economic losses associated with malnutrition have been estimated at 3 per cent of India's Gross domestic product (GDP) (Susan, 1999). The problem of malnutrition can be better addressed through a innovative ICT technologies include mobile phones, tablets, internet, email, global positioning systems (GPS) etc., and their use has coined the terms electronic health (eHealth) and mobile health (mHealth).

eHealth goes back to the development of the first automated pathology reporting applications. A health management information system (HMIS) currently used globally is the District health information system (DHIS). The DHIS was first developed for use in three districts in South Africa in the late 1990s and is now used in 46 countries. Since the mid-2000s mobile phones have increasingly been one of the main tools used to reach clients, support health workers and collect data. In the last few years there has been a proliferation of mobile applications developed for data collection, clinical decision support, eLearning and client self-management.

Common types of ICT interventions in the health sector are 1.Electronic medical record systems. 2.Point of care diagnostics/sensors. 3.Client education and behaviour change messaging. 4. Provider training and education.5. Electronic decision support.

ICT help to address challenges and improve the efficiency and effectiveness of CMAM programmes:

Community based management of acute malnutrition (CMAM) programming has been rapidly scaled up since 2003 and has provided a model which has allowed children worldwide to have improved access to services to manage acute malnutrition in their local communities. In many of the countries where malnutrition is present, governments are supported by various NGOs in developing policy, financing and delivering services for health and nutrition.

CMAM programmes share many of the same characteristics of other programmes in the health system in that they require a patient to be identified with a problem, seen by a health provider, diagnosed, treated with therapeutic or supplementary food and medicine and counselled. This movement of a client between community and facility and between the various intervention areas is shown in the Fig. 7.

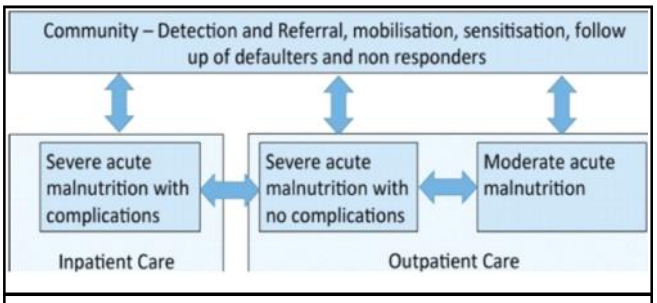

Fig. 7 : Overview of movement within CMAM programme (Source : http://www.d-tree.org/)

Impact of eHealth and mHealth :

A recently published meta-analysis systematically reviewed 26,221 research articles documenting the effect of ICT use on health outcomes (Free *et al.*, 2013). Out of this pool, 75 controlled trials were deemed eligible to compute pooled estimates of efficacy. CommCare, a platform currently used by 50 different organizations in 30 countries has identified significant contributions of mobile technology to maternal and child health (Chatfield *et al.*, 2014).

Current use of innovative technology in health and nutrition programmes :

Health information systems and software :

One of the major features of a health system is the collection of aggregate indicators to collect, track and report on core health indicators. The developed software's are discussed below:

The open source and free software district health information system (DHIS2: http://www.dhis2.org/), is a tool for collection, validation, analysis, and presentation of aggregate and transactional data, for integrated health information management activities. DHIS2 is today

considered as an international standard, and is estimated to cover more than 1.3 billion people in 46 low-and middle-income countries.

World vision has developed an online CMAM database, which not only allows district and regional staff to enter data from the facility level, but also incorporates the flow of information back to the health facility, so they can monitor their own programme's quality and take actions. This feedback loop is a critical component, which is often missing from the reporting processes of many systems. World Vision has realised many benefits including time savings in entering data and generating needed reports and in improved accuracy of data.

Coconut surveillance is a system which builds on an earlier initiative in Zanzibar to report, track and alert the health system to new cases of malaria. This system allows the district malaria control officers to be informed of cases as they occur from the health facilities via SMS, and then collect additional geographically tagged information about the cases at both the facility and household level. This information is then all made available on a dashboard, which allows for real-time monitoring and response of outbreaks as they occur.

Mobile applications for nutrition improvement:

Mobile applications are amongst the most rapidly expanding form of ICT in practice, and can be used at a number of levels.

mHealth applications have been built around a number of platforms and make use of different aspects of mobile technology such as text messaging *i.e.* short message service (SMS), voice and video services and the use of internet connectivity. Depending on the technology, mobile phones may be simple or may be smart phones providing more sophisticated solutions.

The Manthan Project's mSakhi tool also provides health education content within an application, and integrated within the mobile application, so the health workers can use in their daily work. mSakhi was developed to be used by Accredited Social Health Activists (ASHAs) in India, whose role is to provide Maternal Child Health (MCH) services to their community. It combines registration, danger sign screening and counseling (FANTA, 2008) with voice, image and video training content on the same subject matter (Manthan, 2013).

Pros and cons of various interventions:

The Table 2 below attempts to list some of the major types of interventions and the advantages and constraints that may be faced in the use of each ICT interventions.

Challenges:

Despite the promise of ICT to address many of the issues in health and nutrition programmes, there are constraints which may restrict the ability of these solutions to go to scale as widely as necessary to achieve maximum impact.

Table 2: Advantages and constraints of various ICT interventions

Intervention	Advantages	Constraint	Evidence
Text messages to beneficiaries	Wide reach; can be accessed on any device	Cost of SMS; lower phone ownership among target groups (poor, women); restricted to shorter messages	Can improve clinic attendance and adherence to prescribed care (Lester, 2010)
Text messages to health care providers	Wide reach; can be accessed on any device	Cost of SMS; may be difficult to retrieve if provider receiving many messages a day	Modest benefits, may need more evidence
Structured SMS for data collection	Wide reach; can be accessed on any mobile device	Training needs for structured SMS; incorrectly formatted messages may be rejected	Clearly more efficient and faster than paper methods and can improve data quality (Garga *et al*., 2012)
Use of PDAs/Smartphones for data collection	Can have validation built in, run offline/online, transmit data	Cost of devices, power	Trails using mobile phone technology-tools reported reduction in correct diagnoses when compared to the standard (Free *et al.*, 2013)
Use of smart phones by health workers	Can run many applications; greater storage space; increasing smartphone ownership	Greater power needs; may require longer training	Trails using mobile phone technology-tools reported reductions in correct diagnoses when compared to the standard (Free *et al.*, 2013)
Videoconferencing/ telemedicine	Can access expert opinion from anywhere	Requires connectivity; may have greater bandwidth	Feasible to implement, clearly has ability to reach out into rural areas. More evidence needed to show effectiveness

Source : (CMAM, 2014)

Sustainability:

Efforts should be made to ensure that there is a path for incorporation into a larger programme for support, funding and scale up, if the results of the programme are promising. *Ongoing operational costs:* To maintain the use of the ICT solution (airtime, hardware maintenance, etc.) ongoing operational costs need to be considered.

Lack of infrastructure:

This can be in terms of proper facilities to store commodities such as vaccines, as well as lack of power to charge mobile phones or laptops.

Conclusion :

Policymakers and other stakeholders need to be aware of how appropriate ICT-based instruments can help to influence agricultural practice as well as support efforts and initiatives to promote food security and sustainable agriculture.

To realize the full potential of ICT-enabled agriculture, Governments need to provide the following:

– A sound, market-oriented ICT regulatory framework;

– Incentives such as a sound business and taxation environment to encourage investor and donor involvement in ICT infrastructure development.

– Support to research institutions and other nonprofit organizations that use ICT tools to assess and transmit commodity prices, thereby allowing markets to emerge.

– Initiatives that combine existing media channels, such as rural radio stations, with ICT to match potential local demand with global content and to distribute the information widely in the relevant languages.

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