Supporting Chinese Farmers with ICT-based Information Services
An Analysis of Service Models

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Abstract: Over the last three decades, China's agriculture sector has been transformed from the traditional to modern agriculture practice through the effective deployment of Information and Communication Technologies (ICT). Information processing and dissemination have played a critical role in this transformation process. However, there are very limited publications regarding the China's success and lessons learned in utilising ICTs to support Agriculture development and transformation. This paper aims to contribute to a better understanding on how different ICT-based information service models are designed and adopted in China; and to share the knowledge and experience in applying emerging ICTs in disseminating agriculture information to farmers to improve productivity and economic, social and environmental sustainability. The paper reviews and analyses the China's agricultural information service systems and models. Seven ICT-based information dissemination models are identified and discussed. Successful cases are presented to demonstrate the impacts of different service models. The findings provide a useful direction for researchers and practitioners in developing future ICT based information processing and dissemination systems. It is hoped that this paper will also help other developing countries to learn from China's experience and best practice in their endeavor of applying emerging ICTs in agriculture information dissemination and sharing.

1 INTRODUCTION

With the rapid development of Information and Communication Technologies (ICTs), data and information can be effectively generated, stored, analysed, disseminated and used to support farmers and farming communities to improve agricultural productivity and sustainability. Informatization, the transformation of an economy and society through the effective deployment of information and communication technologies in business, social, and public functions, has been a significant phenomenon in China (Qiang et al. 2009) and is regarded as one of the driving forces behind the Chinese government's new socialist countryside (Liu, 2012). The term of Agricultural Informatization has been widely used in China, but has no official definition yet. Based on Li et al (2009), it can be defined as the degree and process of transforming Agriculture sector through the effective use of ICTs in agricultural production, operation, and management. Similarly, Zhan, Zhang, and Yang (2004) define the agricultural informatization as a process in which modern information technologies and information resources are widely implemented in all fields of agriculture and the rural economy to create an advanced agricultural information industry and to promote the development of agriculture, the rural economy and society. Liu (202) provides a sound review about Informatization and argues that similar to the industrialization, that transformed society from the agricultural age to the industrial age, informatization is expected to lead society into the information age.

With the introduction of agricultural informatization, the traditional agriculture has been reformed by advanced ICT technologies, eventually contributing to the significant improvements in agricultural productivity and sustainability. Agricultural informatization is a long-term stimulus for agricultural development and also an important indicator of agricultural modernization. The agricultural information service is one of the critical missions in implementing agricultural informatization. China is seeing a rapid growth in its economy, and farmers are achieving a dominating

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role in the economic development. They have an ever increasing demand for using information in solving farming problems, and making effective decisions. In particular, since China became a member of WTO, its agricultural industry has been strongly affected by markets, resources, and environments. Facing the fierce competition both in the domestic and international markets, Chinese farmers and agri-business managers must be fully aware of emerging technologies as well as markets and sales information to maximize the economic benefits.

Therefore, over the last three decades, Chinese government has invested substantial amount of efforts and money to develop and deploy ICT-based agriculture information service systems nationwide. As a result, many innovative and effective information dissemination models have been emerged and widely adopted (Li, 2010). Farmers have gained enormous benefits from the ICT-based information services. However, existing research on China's agricultural informatization is fragmented and mostly reported in Chinese media (Liu, 2012) which limits the knowledge sharing among wider research communities at the international level. This paper aims to review and identify the ICT based information dissemination models in China and to share the China's experience and best practice in applying emerging ICTs in disseminating agriculture information to farmers and farm communities to improve productivity and economic, social and environmental sustainability.

2 MECHANISMS OF AGRICULTURAL INFORMATION SERVICE SYSTEMS

There are different ways in developing and deploying agricultural information services in China (Xiong, 2008). The service system mechanisms can be categorized into three types: government-led, market driven, and community self-support. Each type has its advantages as well as disadvantages.

2.1 Government-led

This mechanism is based on the government support and the services are free of charge and funded by the government budgets. The rural economic situation is still poor in China; therefore the services financed by the governments are currently still the main mechanism. The government-led mechanism is based on the government management system structure that has a top down hierarchy. The Ministry of Agriculture (MOA) in China has agricultural departments in provincial cities, agriculture bureau or agricultural promotion centres in counties, and agricultural stations in villages. The advantages of this hierarchical system are efficiency in management and communications. However the disadvantages are the government organizations are lack of effective incentives and the services may not always be farmers oriented. Due to the free services offered by the government to farmers, the government-led mechanism is more suitable in the low economic development areas.

2.2 Market Driven

This mechanism is based on the provision of services by organizations that make profit from their services to individual farmers. The information sources are from the leading agricultural enterprises and information providing enterprises. The beneficiary is the individual farmers who are willing to pay for the information. From a long term perspective, the Chinese agricultural information service must follow the market driven mechanism to ensure the sustainable information services. The market driven mechanism is suitable for regions where the farmers have high financial capability and know their information needs.

2.3 Community Support

The community support is organized by local communities; they finance the information provision through their own funds. The typical communities are farmers co-operative organization, professional agricultural associations, industry associations, etc. the beneficiary is the members of these associations. The community support is becoming a more popular and important model in rural agricultural information dissemination because the government has developed relevant policies to encourage the adoption of the community support mechanism. The community support mechanism must follow certain policies and regulations by the governments to make the association legitimate.

3 AGRICULTURAL INFORMATION DISSEMINATION MODELS AND CASE STUDIES

With the rapid development of ICT, the agriculture information service model is constantly evolved and improved (Zhang, 2012). Currently, the agricultural information dissemination models in China can be classified into the following seven types:

1. Web Portal – a collection of relevant web sites to form an one stop centre for users.
2. Voice-Based Service – information dissemination through telephone, i.e. call centres, e.g. Liaoning 12316 Golden Farming Hotline.
3. Text (SMS)-Based Service – jointly operated by Agriculture sector and Telecom service providers, e.g Hunan Agri-Telecom Platform.
4. Online Community – membership system, members involving all stakeholders, share experience and exchange information through interactive service platforms, e.g. farmers Mailbox in Zhejiang Province.
5. Interactive Video Conferencing Service – e.g Shanghai Farmers "One Click and Go" service, or Intelligent Farmers service.
6. Mobile Internet Based Service – information dissemination through smart phone service. 70% 3G coverage in rural China, 60% farmers access the Internet using mobile Internet service, e.g. Agribusiness price information, E-news.
7. Unified Multi-Channel Service Model – utilising multiple methods to effectively disseminate information through telephones, computers, and mobile phones., e.g "3 in 1" service in Fujian

To select the most appropriate models, the information infrastructure, the operating costs, farmers' capabilities, farmers' information consumption behaviour and, most importantly, the local context should be taken into consideration (Zhang, 2012). The following sections analyze the features of each model and demonstrate its applications with case studies.

3.1 Model 1 - Web Portal

The Web Portal is a platform hosting a collection of relevant websites. It is an important and fast information dissemination channel. With the popularization and application of web technologies in the field of agriculture, the number of agricultural websites created in the last decade has been very high. The establishment of web portals promotes the sharing and utilization of information resources, reduce overall investment and maintenance costs, and increase the service coverage and site visits.

Case study: MOA Web Portal

The web portal of the Ministry of Agriculture was established in 1996. It was the first ministry website to establish access to the Internet. The web portal now has contained the websites from different bureaus and institutions under MOA. Currently, MOA web portal includes different types of website, for instance, the governance sites, and the public service sites. In addition to the Chinese native language, English, Japanese, Korean, Russian and other foreign language are also provided, with news, government events, online office, public interaction, and integrated multiple functions of public information services. The portal has integrated abundant resources from agriculture-related departments, allowing the public to access agricultural news, agricultural market information, agricultural technologies, and rural life and culture information.

Operational Features

1. High quality service standards.
2. Comprehensive management and maintenance mechanism.
3. Provision of diversified contents to meet the farmers' information needs.

Service Outcome

The influence of the site has been significantly increased over the years. In the 2013 annual performance evaluation of government websites, hosted by the Website Information Research Center of the Chinese Academy of Social Sciences, the MOA portal was ranked third among the State Council departments, won the management innovation award, government transparency leadership award, and the internationalization award. The portal has 8 million daily visitors from 158 countries and regions.

3.2 Model 2 - Voice based Service

At present, China's rural telephone penetration rate is very high. According to the National Bureau of Statistics, as of the end of 2012, every 100 rural households have 197.8 mobile phones, 42.2 landline telephones. So the voice service is currently a key approach to get connected with the farmers. The

voice service is the use of the call center technology to provide users with expert advice and automated voice services. The farmers can call in to get information and guidance on policy, technology, marketing, business, life and other aspects. In July 2006, MOA launched the 12316 hotline to serve the Chinese farmers. Up to now, the 12316 hotline has covered 1/3 households nationwide, and become a well know brand name to provide the direct connection between farmers and experts.

Case study: Liaoning 12316 Golden Farming Hotline

Liaoning 12316 Golden Farming Hotline was put into operation in July 2005. It is an integrated information service platform catering for the agricultural industry, rural areas and farmers. The project was jointly conducted by MOA and the Liaoning provincial government. Ever since the beginning, the 12316 hotline has opened 66 seats, responding to approximately 3,000 calls every day. At the end of 2013, the hotline had handled 3.62 million cases.

Operational Features

1. Innovative development model. Liaoning 12316 hotline is a joint effort from multiple stakeholders.
2. Establishment of the 12316 “Cloud” platform. Since 2012, Liaoning has upgraded the platform architecture with cloud technology.
3. Development of a standardized service mechanism to benefit farmers. Ite has working staff on duty 12 hours every day, 24-hour automated voice service, serving the farmers all year around.
4. Professional service team. After years of development and accumulation, it now has a team of more than 200 agricultural experts and 60 consultants as its professional service team.
5. Provision of a wide range of advisory services.

Service Outcome

The Liaoning 12316 Golden Farming platform successfully set up a hotline linking farmers to the government, latest technologies, and markets by enabling an efficient information dissemination flow. It is estimated that this service helped farmers to generate revenues of about 30 billion yuan (c.a. 4.5 billion pounds).

3.3 Model 3 - Text (SMS) based Service

The SMS message service model is operated jointly by the agricultural organizations and the telecom service providers (SP). The agricultural information provider edits, audits, and publishes text messages through the specified telecommunication channels. With the increasing number of farmers who own mobile phones, the information dissemination through SMS has become a key service model. Mobile phones have become an important communication media for farmers in managing agricultural production and daily life, and communicating with the outside world. In 2009, MOA launched a short messaging services using access code "12316" at all levels of the agricultural sector.

Case study - Hunan Agri-Telecom Platform (HATP)

In 2006, the Hunan Provincial Department of Agriculture and the Hunan Branch of China Mobile signed a strategic agreement to jointly working on agricultural information dissemination by taking advantages of the mobile phone network platform. Both parties made full use of their respective resources, and helped promote the dissemination in the forms of events, websites, posters, text messages and mobile subscription packages. They established the Hunan Agri-Telecom Platform (HATP).

Operational Features

HATP is a joint effort from both government sectors and private companies. The principle of the management and maintenance of this platform can be summarized by a few key words: Led by government, Joined by enterprises, Adapted to the market, Benefiting the farmers. The expert team and the market information reporter team are the most important teams for this service model. 335 experts were employed in the first round with 60 of them being the core experts responsible for information collection and consultation. The 30 market information reporters collect market, pricing, and supply/demand information from various types of sources. The platform highlights a single access to multiple varieties of agricultural information with the lowest cost and highest efficiency.

Service Outcome

From 2007, the Hunan agricultural information service platform has brought enormous benefits with regard to guiding agricultural production, improving agricultural productivity and efficiency. It provides timely and effective technical guidance in dealing with crop drought and frost, pests, etc. and has been highly appraised by the users. Up to now, the platform has more than 10,000 items of information released, 3 million phone consultations completed,

and 3 million subscribers, resulting in better social and economic benefits.

3.4 Model 4 - Mobile Internet-based Service

This model is developed by taking the advantages of mobile Internet technologies. Users can be connected via handheld devices anywhere at any time. Agricultural information is disseminated to formers on the move or located in any agriculture production sites. The mobile information service is ubiquitous, portable, and geographical identifiable. It has no temporal and spatial restrictions. This service model is expected to dominate the future information dissemination models (Mao, 2012). According to "China Internet Development Statistics Report" in 2012, 3G network coverage in rural areas has reached 70%, the number of smart phones increased by more than 30% per year in the rural market, and rural Internet users increased to 146 million, of which 60.4 percent of the rural Internet users use the mobile Internet.

Case study- E-Price App

The price fluctuation in agriculture products has increased over the years. This has brought negative impact on producers' economic stability and income. The E-Price App is developed to help farmers and agri-business managers to deal with the price volatility. It utilizes the Internet, cloud computing, and smart phone devices. The App releases agricultural products prices provided by a collaborated source from government agencies, agricultural producers, agri-businesses, consumers, etc. The App has functions like price push, price comparison, real time inquiry, agricultural news, location identification, tailor made price reporting, and bidding and match making. The App service provides the price information service in different trading processes such as: production, logistics, retail, agricultural materials, price analysis, etc.

Operational Features

The E-Price App provides real-time prices information for users. The price information comes from different sources, including government agencies, communities, enterprises, business units, and individual consumers. Features of the platform include:

1. High user participation. The App allows price reporting by users. Users can act as both a price reporter as well as a price information user.
2. Accurate, reliable, timely updated service. The price information comes from different sources to ensure the accuracy and reliability.
3. Personalized information service. The App allows user customization. Users can subscribe to receive the price information based on their specific interest. The App also has search functions to identify the users' current position and provide location based price and products information.

Service Outcome

The E-Price App is mainly operated by the enterprise in collaboration with relevant agricultural departments. It has been deployed in a number of provinces and cities and will expand its use with comprehensive contents, unified standards, and nationwide coverage. The App has effectively helped the government to monitor and respond to the price fluctuation.

3.5 Model 5 - Online Community

In the online community support service model, people form a community to help each other. They register themselves in the service system with authenticated personal information. In this online community service model, members of the communities include government officers, agri-technical professionals, industry associations, agri-enterprises, and farmers. They chat online using their computers and mobile phones. In the Eastern regions of China, the computer penetration rate is high in rural areas. Farmers in these regions use the Internet to obtain information. Thus the self-support service model suits those areas very well. Farmers carry out regular online communications with each other, helping each other. This model is remarkably successful in Zhejiang province of China.

Case study - Farmers'Mailbox in Zhejiang

Farmers' Mailbox is a public service platform customized to serve local farmers community in Zhejiang. Farmers register themselves with authenticated personal information. The platform provides services in e-commerce, e-government, agricultural services, and information integration. Farmers have an easy access to the platform with computers and mobile phones, chatting with each other, searching information, etc. This platform was developed mainly by the Agriculture Department of Zhejiang Province and China Mobile in Zhejiang. Agricultural sector in provincial, municipal and county levels share their respective responsibilities in the management and maintenance of the community platform.

Operational Features

1. Rigorous management system. The platform is managed in a hierarchical structure covering the provincial, city, county, township, and village administration. This hierarchical management system guarantees the reliability of information.
2. Smooth contact system. The communication network comprises of contact stations at the provincial, city, county, township, and village levels. The platform coverage of stations is 100% at the provincial, city, county, and township level and 95% at the village level.
3. Reliable system with authenticated information. The Farmers' Mailbox project requires real name registration. Members registration is verified by the local authorities to ensure that user information is authentic and reliable.
4. Constant improvement of service quality. More functions are added to the platform over the years to meet the growing requirement from the farmers.

Service Outcome

The mailbox platform serves as a unified agricultural information service platform in Zhejiang, covering five administrative levels. It is estimated that approximately 180 million yuan is saved in total. At present, Zhejiang farmers mailbox has 2.6 million registered members, forming a stable customer base.

3.6 Model 6 - Interactive Video Conferencing Service

The video conferencing service model is the use of the Internet to achieve real-time video and voice communications. The most notable features of this model lie in a visual and face to face interaction, multiple service approaches including one-to-one, one-to-many, and many to many services. For example, farmers can ask questions and show the pest samples to the experts through the video to help the experts offer accurate diagnosis and effective solutions.

Case study – One Click Farmers Service Platform in Shanghai

The Information Center of the Agriculture Committee in Shanghai developed the "integrated information service platform for farmers " called "One Click Farmers Service" and deployed intelligent terminals to farmers. The platform collects and disseminates relevant information through the terminals in Shanghai. Information provided covers the policies, agricultural technology promotion, disaster warning, distance education, news of village affairs, expert advice, etc. The platform serves farmers free of charge. The platform also can facilitate a multi-party video chatting, two-way interactive video chatting, and mobile video chatting. Intelligent information filtering and automatic information receiving are also featured in the platform.

Operational Features

The platform uses the advanced video and audio integration technologies and has established a multimedia call center by integrating analog voice calls, video calls and SMS text messages. Based on the Internet technology, the platform enables remote consultation and communication between experts and farmers. The multimedia platform allows farmers to consult the experts either through 12316 hotline or video calling with a single click. Farmers have the rights to choose the experts. The platform also supports a 1-to-8 video conferencing system. This system can also serve the purpose of online training, and trainings can be recorded for future review.

Service Outcome

The two-way interactive video service enables a real time "face to face" communication between farmers and experts to solve problems in agricultural production practices. The platform has been further enhanced and now it has connected experts from city and county levels, and reached a seamless video connection between farmers and experts. The platform provides all-year-around consultation services in a simple, direct and easy-to-understand way.

3.7 Model 7 - Unified Multi-Channel Service Model

As each service model has its advantages and disadvantages and suits different application contexts, an integrated service model has been explored and developed to facilitate the information dissemination using multiple communication channels as shown in figure 1. Currently, each province is exploring the best way to carry out agricultural information dissemination by coordinating the different service approaches and models, to maximize the service effectiveness and efficiency.

Case study – "3 in 1 Service" in Fujian

Beginning in 2009, Fujian Provincial Department of

Figure 1: A unified multi-channel service model.

Agriculture attempted to unify the information resources and services by integrating telephony voice service, Web applications system, and mobile Internet service into a unified "3 in 1 Service" model. "3" represents landline telephone, personal computers, and mobile phones. Farmers can use these 3 main communication media to access information anywhere and anytime.

Up to now, the voice service has been the most popular information dissemination channel that reached almost all the rural population in the province. Computer terminals have been deployed in 354 villages. The 3 in 1 service platform provides agricultural consultation, training, agriculture information, etc.. The Apps for both Android and iOS were developed to provide similar service functions as those provided by the personal computers. The service platform has 16 service zones covering 46 service categories.

Operational Features

1. Sound system development concept. The service system was developed based the concept of "Government-led, demand led, top-level design, collaborated efforts".
2. Service concept. "3 in 1 service" aims to provide free services to the public in a comprehensive, convenient, professional, and personalized way.
3. Active promotion of the service. A number of proactive approaches are in places to widely promote the service in the province.

Service Outcome

The "3 in 1" service platform is still in its early stage and it is expected that this unified service model will significantly improve the coverage of the service areas and quality of service with more comprehensive information sources and quality support.

4 DISCUSSION AND CONCLUSIONS

Over the last two decades, the Chinese government has invested a significant amount of efforts and money in agricultural information dissemination services and this has been reflected in the Communist Party's annual committee's policy documents (e.g. Central Committee of the Chinese Communist Party & State Council, 2006, 2007, 2008, 2009, 2010). These investments have contributed greatly to the agriculture sector's social and economic improvement (Li, 2010). With easy access to information, knowledge and experts' support through ICT-based information services, farmers are able to improve their income and economic situation through better practice, for example, in dealing with disasters, pests, trading, marketing, and with raised awareness of government support and favorable policies. However, despite of the great success in using ICTs to provide information services to Chinese farmers, there has been very limited publications to disseminate the best practice of Chinese models to research communities worldwide. Therefore, this paper aims to address this gap. It reviewed the current literature on China's information service systems development and implementations. Three mechanisms for developing and implementing information service systems are discussed, which are named as: government-led, market driven and community self support. Seven information dissemination models are identified and demonstrated with case studies.

The key impact of agriculture information services in China can be highlighted in the following areas:

- Improved the efficiency of Agriculture Services, e.g. "12316 hotline", "Unified 3 in 1 services", etc.
- Increased farmers' income
- Improved agriculture productivity
- Reduced the digital gap between rural areas and modern cities

However, there are still many barriers to the further deployment and utilization of ICT-based information dissemination due to the following major constrains:

- Poor IT infrastructure and Internet coverage in remote rural areas
- Lack of technical support staff
- Limited information and knowledge sources
- Management and monitoring system not fully in place yet
- Lack of rigorous information governance and

quality controls

For other developing countries that are still in the early stage of developing and deploying ICT based agriculture information dissemination systems, China's experience, lessons learned and best practice can be considered and adapted. The most important lessons in China can be summarized as the following:

- Government investment and support
- Top-down approach
- Branding and raising awareness, e.g. 12316 has been well-know name for Agriculture Information Service.
- Motivating farmers to adopt the service, e.g. free services, opportunities to report fraud and illegal products, etc.
- Government and enterprise collaborations
- Effective use of village based networks and designated information officers

Looking forward, with the popular use of 3G and 4G technologies, we can expect improved functionality and enhanced user experience in agricultural information dissemination. For example, 3S (GPS, Remote Sensing, and GIS) technologies will also be widely applied in agricultural informatization. Agricultural information in its nature has a spatial component, so 3S technologies which deal with spatial data would be very useful in enhancing agricultural information service. We have already seen many effective agricultural information systems where 3S technologies are integrated in China, e.g. intelligent fertilizer formulation system. In the future, all of these emerging ICT will play a significant role in agricultural informatization. Having reviewed and analysed the current ICT-based information service models in China, the following suggestions can be provided for future development and research:

- Consolidating and harvesting the investment made in the last decades
- Transforming agriculture sector into the modern digital agriculture to further improve social and economical benefits
- Further improving the digital access by farmers with technological advances and skills improvement
- Adopting the Internet of Things in agriculture sector, e.g. GPS, GIS, RFID, Remote sensing, Smart device for precision agriculture, sustainability, environment, food safety, etc.
- Exploring and utilizing Big Data and Agriculture Analytics Clearly indicate advantages, limitations and possible applications.

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