The Impacts of Information and Communication Technologies (ICTs) on Farming in Miyun County, China

by

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Abstract

The Impacts of Information and Communication Technologies (ICTs) in Miyun County, China

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It is well known that agriculture is an essential industry for both developed and developing countries in the world, especially for developing countries to satisfy people's basic food and clothing issues. However, in general agricultural development is relatively underdeveloped compared with other industries in most developing countries because farmers often adopt conventional farming methods and the Governments often ignore the role of agricultural development for national economy. A case study was conducted of poor Chinese farmers, where the government provided one-to-one information and communication technology (ICT) approach in a pilot project for those farmers to change their conventional farming methods and access new social media in Miyun County. The epistemological approach of the study was Grounded theory of analysis findings. Key informant interviews and semi-structured interview method were used to interview 71 participants at the policy proponent, agricultural technician and farmer levels. Feedback was also obtained about the strengths, weaknesses, opportunities and threats of the ICT program, as identified by a focus group approach. The implications for the ICT project in Miyun County include the improvement of capacity development, economic benefits, and social networks. Obstacles preventing ICT development include outdated policies including the lack of a free market and individual ownership of land as well as Hukou

system (a population registration system in China) for controlling internal migration and insufficient infrastructure development and integration of social resources.

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Contents

List of Figures

List of Tables

Chapter One: Introduction

Introduction

Due the essential role of the agriculture for society and economy, both developed and developing countries regard agriculture as the first development goal. Nowadays, more and more new advanced technologies were used for agriculture, such as satellites, the Internet and social media. The use of the technologies and divides in both developed and developing nations can be used to improve agricultural information and farming methods with transformational development (Lu, 2001). In particular, China is a predominantly rural country and is experiencing the New Rural Campaign stage (the increasing the depression of the rural economy and eliminating rural-urban inequalities stage) (Jia & Fock, 2007) to improve agricultural production and food security throughout the nation. Social media have rapidly replaced conventional communication tools in China but a digital divide remains between those who have access to social media and those without the ICTs. As the necessary tools of developing modern agriculture, Information and Communication Technologies (ICTs) can facilitate changes both in social and economic aspects. This research project is about China's agricultural ICTs development in a rural area--Miyun County-- to discover how people navigate and transform the ICTs in the Chinese context.

Not only in the ICT program but throughout the country, the people who are around 40-55 years old are the main farmers in China. Moreover, almost all farmers still use the simple functions of cell phones and are far away from the modern urban civilization.

Farmers or agricultural technicians usually apply either large mechanized farming or conventional small family farming on agriculture. There is a gap between more educated versus less educated farmers which raises the question of how to encourage less educated farmers to access and use modern social media and to help overcome the digital divide enabling these technologies to go the 'last mile' to reach these more disadvantaged farmers. The thesis explores how the Agricultural Information Institute (AII) associated with the Miyun Science and Technology Committee (STC) used ICTs to improve farmers' agricultural activities by the help of the agricultural technicians with the use of the smart phones and laptops.

Feasibility

Information and Communication Technology (ICT), literally means the integration of information technology (IT) and communication technology (CT) which combines the mobile and computer networks together. It is convenient and popular for farmers who use the ICTs in their agricultural field activities. The STC provides agricultural knowledge and ICT training to the agricultural technicians, and monitors the operation of the project. It is also responsible for the maintenance of the ICT tools. The program and agricultural technicians in Miyun County are assessed and monitored by the STC. For the AII, it was important to test the project operation with the use of the ICTs in this pilot. The support of the STC made the survey easy to collect data and feedback, to explore whether or not farmers and local technicians participated in the new type of farming methods, and whether the ICT project is similar to other agricultural approaches which only focus on

agricultural economic development or promote farmers' abilities to adapt to the development of modern agriculture.

Research goal and objectives

This thesis is about the usage of ICTs at the village level. The AII allocated smart phones and netbooks to agricultural technicians for every village with over 50 households in Miyun County. The research goal of the case study is to explore the impacts of ICTs in Miyun County in the year 2012. That means to discover whether farmers learned and were empowered through the project. To build long term relationships amongst the policy proponents, agricultural technicians and farmers are to provide new information and techniques to every farmer.

There were three objectives for the research. The first was to investigate how the ICTs have better supported farmers' long term agriculture and to identify the advantages or disadvantages of ICTs. The second objective was to understand whether and if so, how the ICTs increased and protected agricultural products. The third was to identify the opportunities that provided by ICTs if improved such as farmers' awareness of sustainable agriculture and whether it is conducive to agricultural large-scale production and centralized land management in this field.

Implication of the thesis

This program is one of the first research studies that connects ICTs with land policy. The ICT program is a new farming approach for Chinese agriculture. It is the first to consider small/individual farmers' farming abilities in China's rural areas. There was no

precedent for the government to provide smart phones or laptops to help every farmer at the grassroots level. In China, most agricultural projects have focused on the majority of farmers or the whole of farming, such as the overall mechanization in a village or only offering new seeds to farmers. Those top-down agricultural development approaches did not bring greater benefits or development for the farmers who often have a low level of education and do small family scale farming in rural villages. Therefore, the research sought to discover whether and if so how the ICTs improve farmers' own potential abilities so as to drive the rise of Chinese agriculture and reform agricultural practices from the view of the farmers themselves.

Structure of the thesis

To explain and expand the ICT program in Miyun County, the thesis consists of seven sections. In chapter one, the introduction of the thesis and an overview of the research goal, objectives, feasibilities and implications are described. Chapter two is the literature review that provides an insight of the development of the ICTs in rural China by other agricultural researchers. Chapter three enumerates the main methods and the analytic approach that were used in the survey. Because of the small sample (a total 71 respondents), only qualitative research methods were used. Chapter four is the context of the research. This chapter elaborates the advantages and disadvantages for ICTs' developing in Miyun County, and also analyzes Chinese farmers' situations in Miyun County. Chapter Five: Briefly provides tables and explanations of the findings among three levels: policy proponents, agricultural technicians and farmers. Chapter six further

discusses the findings based on Chapter Five in the specific context of China. The last chapter, Chapter Seven, is the final summary, conclusions and recommendations of the research.

Chapter Two: Research Literature Review

Introduction

The research is about the development of China's agricultural information and communication technologies (ICTs) in a rural area. Due to China's different policies and economic system from most western countries, the land use policy and local farmers' situation needs to be described. The main arguments and contributions around the issues of Chinese rural agriculture from other researchers require me to understand and identify, especially in the research context – Miyun County. This literature review is involved with the background/ culture of China, rural agricultural circumstance and ICT's development in rural areas. In addition, with the development of ICTs, more and more farmers accessing new information and technologies, the relationships between ICTs and sustainable agricultural development and large–scale production management are bound to consider by the researchers.

Due to globalization and market reform, China's Information and Communication Technologies have developed very fast. China is undergoing rapid changes and, as the world's largest, low-income country, it has also attracted the world's attention because of its significant and distinctive approach to development (Yu & Li-Hua, 2010). It is well known that China is a predominantly rural country, the same as many developing nations. If, the researcher wants to investigate the Chinese agriculture, he/ she has to understand the background, Chinese characteristics and policies of China. Because of the substantial

institutional issues and innovation of the economy, Chinese farmers experienced institutional reform, market reform, stagnation and a New Rural Campaign in four stages since 1950s (Jia & Fock. 2007). Given small-scale/ family farming methods in China, this reduced farmers' competition, after 2006, the government started to pay more attention to ICTs' development in rural areas. The Chinese government is now committed to agricultural production and to develop sustainable agriculture practices with ICT methods.

Through analysis of the readings, one can better understand Chinese agriculture. Through the empirical research reading, understand the Chinese farmers' current situation and how ICTs can be used for agricultural development. Given China's different farm and land policies, to understand how the government and farmers attempt to improve agricultural methods to increase China's agricultural economy is important.

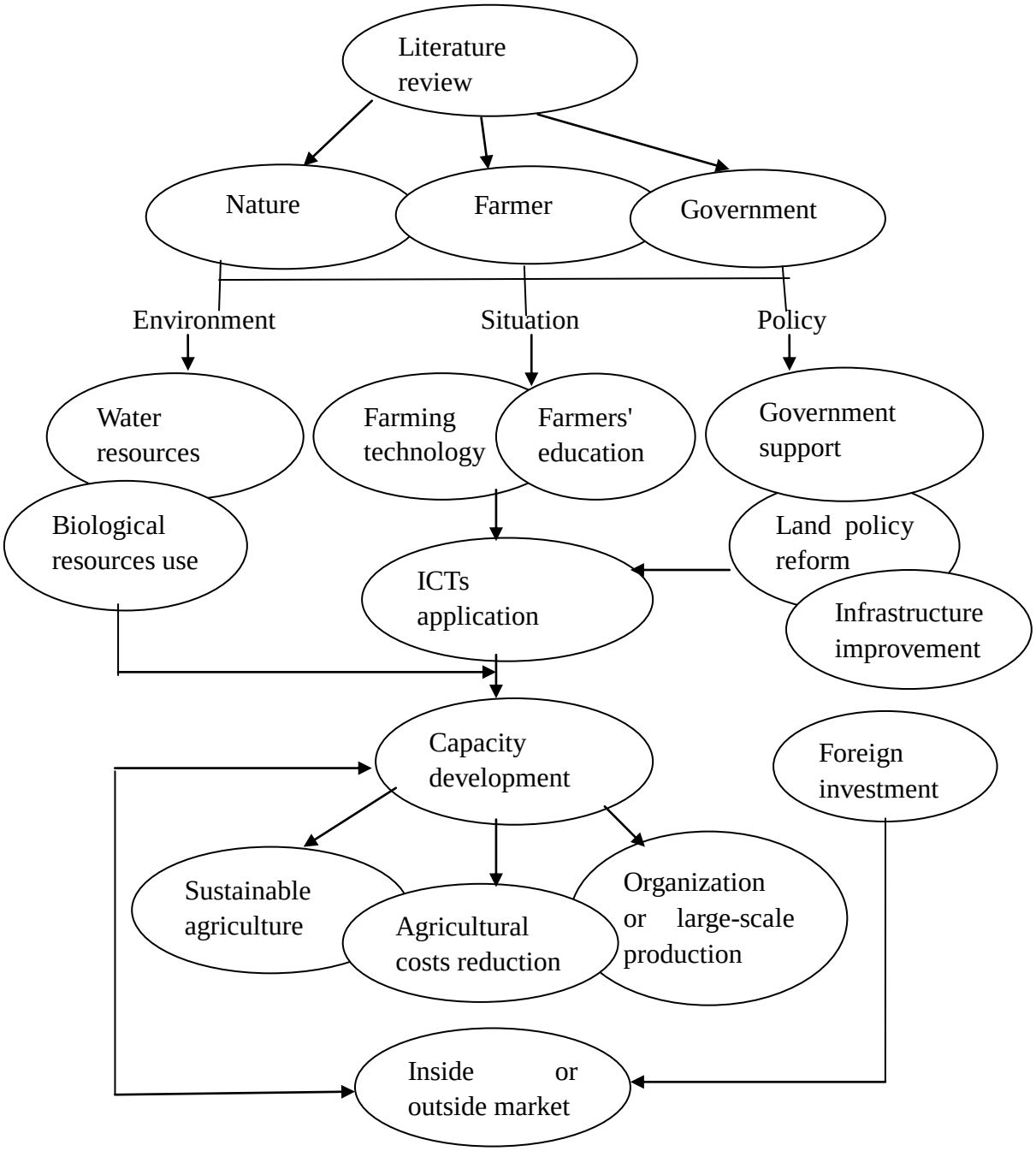
Framework of the thesis

The literature provides knowledge about the Chinese rural background and farming development, which helps the researcher understand China's improved use of the information policy and agricultural development in preparation for the empirical research on the ICT impacts in Miyun County. Since the Chinese farmers only have lease and rent rights on the land, how can farmers' competitiveness be increased and in which way can the farmers obtain maximum benefits through the use of ICTs for sustainable and/or larger-scale agricultural development? Understanding these issues - are the researcher's primary goals for the thesis. The research is also interested in learning about what the

one-to-many ICT method of agricultural extension can add to China's one-to-one agricultural extension approach.

The framework below combines all of the various types of capital together and including the government, farmers and nature, and reveals the relationships among them. In order to improve and spread ICTs in rural China while protection nature, farmers and the government are required to collaborate at every level. For example, the government reforms land policy to give more rights to farmers so that they can be concerned more about how their farming affects land ecology in the long term. In addition, with the improvement on the use of ICTs, farmers' capacities will be promoted and they will be willing to develop sustainable and larger-scale agriculture so as to reduce farming costs and increase their incomes. Nonetheless, if there is one aspect not included in the network, farmers' capacities are not able to completely develop and plan for the agricultural development. Such situations will be discussed in the following chapters.

Figure 1: Framework showing Network of Capital Linkages



Background of China's agriculture

Given the different development trails of China (socialism economy), the chapter will

explore the historical background on Chinese agriculture. China's agricultural development has experienced various innovations from the 1950s to now. During the 1950s-1970s, the government concentrated on promoting the economy, urbanization and industrialization but ignored agricultural development (Jia & Fock, 2007). Although, as Jia and Fock (2007) indicate, from 1985 to 2000 there was no obvious growth in agricultural production in rural fields, as the increasing inequalities between rural and urban grew and the decreasing production supply occurred, the government still reformed substantial institutional issues and developed a 'New Rural Campaign' (Jia & Fock, 2007).

The 'New Rural Campaign' is concerned about confronting the rising inequality between urban and rural areas and food security. According to Jia and Fock (2007) the government returned agriculture back to the top of the political agenda in 2006. They also agree that the government should focus on capacity-building and institution building of farmers which pay special attention to various markets and their participation rather than in a top-down mode. However, the bottom-up development mode needs to be based on a well-developed structure for transmitting information and norms among economic agents (Jia & Fock, 2007). China, at present, still relies on more top-down policies to improve and regulate market and production methods because of this special land policy and the Hukou institution. Chinese farmers only have rights for 30 years to use land and only households who have rural Hukou have the land.

Hukou in China means the person who registered in a city or village where he or she

was born cannot move to other places without losing social benefits. If he/she wants to live in another city, the person cannot get any social benefits in another city unless he or she meets the city's staying conditions which almost always have to do with education level or housing. To obtain more income or better livelihood, many farmers would rather get rid of the rural identifications and land to obtain urban registration, or some of them would prefer to work in the city by becoming migrant workers. Such people were in the rest of the economy and felt deprived not only of productive opportunities but deprived of a social safety net as well (Jia & Fock, 2007). As Sun and Fan (2011) argue, Hukou divides China's migration into permanent migration and temporary migration. Although the Hukou reforms of the Chinese government have changed over time, the gap between permanent and temporary migrants did not narrow. Instead, a large number of rural people have expanded the temporary migration streams since 2000 (Sun & Fan, 2011). Moreover, Sun & Fan (2011) also indicate that the elites' requirements for migrants make the temporary migrants disadvantaged in social and economic development of China.

For the sake of the 'New Rural Campaign' and ICTs development, in order to reform the Hukou institution and give more land rights to farmers, it is urgent for the Chinese government to undertake this economic reform (Deng, 2012).

Though Chinese agricultural land program is credible and accepted by the nation (Ho, 2005), Chinese farmers have no power or private the land. All land in China is owned collectively so that it belongs to the nation and village, not individuals. Farmers just lease the land and they cannot sell the land. This means that land tenure research needs to

concentrate on policy and law-making at the national level rather than the user level. At the user level, in the light of improving agricultural productivity and sustainability and the need to reduce the costs of farming, researchers had better start from the perdpective of developing farmers' capacities and technological abilities. Due to these different land polices in China, spreading ICTs among Chinese farmers has some challenges. For instance, with rapid economic development and population growth, more and more transport roads and residential areas occupy large amounts of arable land. There is only 1.33 mu (1 mu =0.16 acre) per person (Chinese official statistics, 2010) in China. Since there is less and less of the arable land, developing a sustainable land development model to ensure equity between productivity and efficiency in land use is the key of the Chinese policy.

Due to the limitations of land in China, Deng (2012) argues that land planning and management is the primary factor in Chinese land structural reform. He also encourages the use of ICTs in land productivity improvement. The Estimation System of Land Productivity (ESLP) is an important predicting model to restore degraded cultivated land by improving the agro-environment so that full use of the land can maintain future land productivity (Deng, 2012). The ESLP model was adopted in the North China Plain. The North China Plain is the grain production base in China, which covers Beijing, Tianjin, and five provinces Hebei, Shandong, Henan, Anhui and Jiangsu, the main agricultural areas of China, so these regions' improvement will drive the agricultural development in other areas. In Jiangsu province, about 99.5% paddy fields were converted to rural

settlements from 2000 to 2006 (Liu, 2009). In Huabei Plain, arable land is used for cultivating cash crops such as fruits and vegetables instead of rice or grain, and most farmers work in the secondary sector or township enterprises (Liu, 2009). Because there is less arable land, farmers are forced to improve land use efficiency and to minimize destruction of the region's ecoenvironment. As Zhao says in 2007, China's sustainable agricultural development has encountered many obstacles: water-use shortage, arable land loss, inappropriate usage of fertilizers and pesticides and environmental degradation. Such problems should be solved by land reform and ICT development.

Given the fact that the Chinese farmers cannot exchange and transfer plots of land, this partly hampers mechanization and large-scale agricultural activities in China. As Ho pointes out in 2005, the lack of a ownership of the land and the fact that land cannot be used as collateral that impede farmers' efforts in developing sustainable agriculture and prevents foreign land investment from cooperating with private Chinese industries. Though the Chinese land policy limits the development of agriculture, Chinese farmers' situation has made a huge move in 20 years. Income per capita in the rural area has risen 10 times according to Quan's and Liu's article (2002). The food consumption and basic living conditions have benefited rural people (Quan & Liu, 2002). This means that the 'New Rural Campaign ' has improved rural modernization and information requirements. Chinese agricultural reform has developed agriculture from meeting each household's food needs to meeting the needs of much of the whole society.

Chinese national support for agricultural development

Undoubtedly, within 30 years, Chinese decision-makers are aware of agriculture as a mainly "feeding industry" to a sector that requires strong attention in order to achieve objectives of "balancing growth" (Jia & Fock, 2007) and increasing farmers' income. Rural infrastructure, education, health, social security and environmental sustainability have been included in the rural development strategies (Jia & Fock, 2007). However, according to the China-DAC Study Group, for feeding 1.3 billion people, the Government must continually adjust rural policies and social welfare to improve rural incomes and food security. Especially in China, developing agriculture and ICTs employs top-down strategies, generating economies of scale in production and with protection of geographical areas. The development of agro-industry enterprises and supply chains are imperative for government support (China-DAC Study Group, 2010). As Deng (2012) points out, the Computable General Equilibrium (CGE) model (a model of using economic data to estimate changes in policy, technology) is used to analyze the influence of trade environment, economic strategies and institution arrangements on regional land use structure. This model can be assumed to be the result of changes in agricultural policy adjustments or farmers' behavior (Deng, 2012). Such digital divides are at the top level, and with government support the model can be implemented very soon.

As Chen (2010) says, before the leadership of the Communist Party of China, Chinese peasants lived in dire poverty and the grain output was only 209 kilos per capita in 1949. With the changes of the Chinese farming proportions, the forestry, animal husbandry and

fishery have also increased sharply along with agriculture. Gradual formation of the market system with market demand and determining prices of farm products according to supply and demand under government macroeconomic control (Chen, 2010) are also the essential changes in the economic structure of rural areas. On the other hand, although there were tremendous changes within China in 60 years, the strengthening of government support of policy and finance are still the fundamental elements for agricultural and rural development.

Individual farming system in rural China

With the increasing economic growth and consumption, rising farm productivity is the only possible way forward in China with its limited land and rural labor resources. However, given Chinese agricultural development throughout in many years with its large population and small farming land, Jia and Fock (2007) indicate that the Household Responsibility System (HRS) (reallocated collective agricultural land to individual rural households, and the households have the land use and crop selection rights) has been adopted in almost all of rural China. In 2010, the China-DAC Study Group also agreed that small farmers are more flexible and dynamic for China's dramatic economic transformation and structural changes. Moreover, farmers would like to access science and technology for their own family farming and it is easy for institutes at the farm-level to practice agricultural extension to disseminate knowledge and build farmers' capacities.

ICT program for Chinese small householders

Obviously, ICTs can contribute to rural poverty reduction in various ways. Since the

Chinese farmers who farm the land as families/individuals are independent from the government, if the government wants to develop sustainable livelihood strategies to improve rural living conditions, it has to consider all aspects of rural agriculture and policies so that information and communication skills become major catalysts to extension farmers' modern capacities (Soriano, 2007).

According to Soriano (2007), the government trained the tele-center's staff with Web/Internet skills and a few agricultural techniques every month. Then the tele-center staff member helps the farmers to seek the information which is needed in the village. Such methods make villagers want to visit the centre, but farmers don't have much time to leave their work to go to the centre during their farming period. In addition, since seniors and women are the main labour power in rural areas, these people are slower to learn computing skills than young people and men. Therefore they need the technicians to pass on new information or agricultural knowledge face to face, even translating the information into farming words which they understand.

Soriano's program is different from the ICT program which I am researching in Miyun County. The program of Miyun County is to give laptops or smart phones to one technical farmer in each village with over 50 households. The agricultural technicians timely instruct or solve every farmer's problems on agricultural skill or management. This is more effective and flexible than Soriano's (2007) program and saves farmers' time. Soriano also indicates that compared to road construction or water dams, farmers think ICTs are the most valuable skills because farmers need to get recent news, practical

agricultural technology, pest management and marketing information and so on based on the use of computer skills. With the advance of Hi-tech agriculture, farmers are more and more reliant on ICTs in farming rather than for communication (i.e. e-mail). The key of the ICTs is to be a convenient tool for improving farmers' own capacities.

For the same purpose, the Food and Agriculture Organization of the United Nations (FAO) established a study group through the Information Centre of the Ministry of Agriculture in January 2003 to analyze the impacts of ICTs in rural China and then the FAO created models on the same principles for other developing countries (Zhong, 2004). Zhong points out that this model was showing that in China a rural market information services network can gradually connect provinces, cities and counties, establish and link with the leading enterprises of agriculture, wholesale markets, intermediary agencies and large households of production and business operations. He also indicates the news media, agricultural social service organizations, the agricultural television/ broadcast and the Internet are important communication tools in rural areas. Similarly, Miyun's program also focuses on the ICTs, like FAO's to promote farmers' capacities. Through FAO's surveys, the researchers identified that the quality of information service does not completely depend on local economic conditions. Instead, the awareness of the local government about the need for a service and what is involved in providing it is essential in order for the use of ICTs to grow and contribute to improved economic well-being (Zhong, 2004). If the local government understood the importance of agricultural ICTs and issued supportive policies and adopted measures to promote the development of a

service system in rural areas, agriculture and the economy would develop rapidly. Such is the case, in Miyun County, the use of ICTs is active and widespread since the farmers received the local government's (Science and Technology Committee) strong support.

The development of ICTs in other countries

The program of ICTs for sustainable agriculture and food security has been implemented by InfoDev in Africa in 2009. InfoDev indicates that given the key role in improving the availability of agricultural production and market information, ICT-based marketing can spur farmers to adopt organic fertilizers to meet market demand and protect their livelihood by improving land quality, thereby reducing farm costs. In Africa, the InfoDev launched Capacity-building workshops for local community officials, farmers and agricultural extension workers. Like Soriano's (2007) program, such modes are not suitable in the Chinese context for 871 million farmers (67% farmers of 1.3 billion populations) in China. It is not realistic to teach every farmer to access ICTs, especially for less educated and older people.

Also in 2009, as the ICTs can efficiently improve agricultural production and income, as well as eliminate rural-urban differences and rural poverty in limited natural resources, Nin-Pratt et al. (2009) compare ICTs efforts between China and India. Compared with India's agricultural productivity growth, China's modernization strategies were largely market driven and both production and productivity grew quickly (Nin-Pratt et al., 2009). In fact, there was a rapid increase in Chinese productivity and input or output (4.4%) during the 1990s; but in India, the Total Farm Productivity (TFP) growth was only 0.3%

(Nin-Pratt et al., 2009). The technical changes in Chinese agriculture pushed the technical frontier and growth in TFP, such that the Chinese output growth rate was almost twice the rate of growth in India. Such comparisons between China and India showed that changing fundamental technologies such as the use of the ICTs strategy conforms to Chinese agricultural needs and economic development.

Basic stations for development of ICTs in China

With the development of China, the government provided various policies and technologies to integrate the farming source and the market. According to Yu (2011), Beijing, where Miyun County is located, has built resource platforms and a service system construction, and the information technology application in rural areas. Although the Chinese government offered the Internet in rural areas, the Internet penetration rate was only 15% (Yu, 2011). The new countryside and cultivated new farms just developed around big cities recently, like Beijing. The increase in rural information around Beijing was amazing; the coverage of radio, TV and network has achieved 100% (Yu, 2011). For management and for the farmers, Beijing's new village and technology hotline:"12396" offers technology information and consulting services by agricultural experts. However, the farmers' inadequate education level and short agricultural-related resources make rural ICTs application, economic and social development difficult. This requires farmers to improve their own skills and capacities to adapt to the development of agriculture.

In order to find an efficient strategy to spread ICTs in China, the Agriculture Information Institute (AII) selected Miyun County and three other Chinese regions to test

the use of ICTs in rural areas. AII provided smart phones and netbooks to technicians and gave them agricultural training within local offices. The agricultural technicians have to grasp new agricultural information and management techniques to improve farmers' access to agricultural information. The agricultural technicians are the key bridge between agricultural information diffusion and learners. They can offer timely information for farmers' problems and help them solve the problems quickly. To farmers, who often don't understand the new skills of farming, the technicians provide hands-on skills.

Simultaneously, Zhao et al. (2007) also state that science and technology had pushed forward China's agriculture development. Up to 2000, science and technology contribution was 45%, and had increased by 25% since 1957. With the decrease of cultivated land and population growth, the grain demand had increased. At the same time, the demand for vegetables, fruits, dairy and aquatic products also increased (Zhao et al., 2007). To meet the demand, the Chinese government had to add investment for agriculture and to improve agricultural structures to maitain sustainable agriculture in China. The Chinese farmers were provided government help for irrigation, machinery, agricultural sciences and technology. For many challenges on agricultural development, ICTs can help to solve most problems. For example, current flood irrigation can be transformed by small border irrigation to save land and to improve irrigation efficiency.

In this big country, irrigation is another challenge, especially in the North China Plain. The research target is Miyun County, which is located in the North China Plain. The

North China Plain is 150 thousand kilometers, contains 65% of the agricultural land of China but only 24% of its water resources (Henry, 2004). Around Miyun County there are mountainous areas and water use is relatively wasteful and inefficient. According to Henry (2004), though over 70 percent of total water use is used for agriculture, 95 percent of the irrigation is done through overflow and open water channels (ground flow) in China. The overflow system loses more energy than drip irrigation (low flow irrigation) and is costlier. The government encourages the use of water saving technology, but this is a huge change and higher fee for 1.3 billion people in China (Henry, 2004). Henry indicates that up to 2004, the Chinese government had invested 3 billion US dollars for agricultural irrigation and to train personnel on the technology. This means the government is aware of increasing personal capacity that is the key of sustainable agriculture. For the drier environment, most farmers of the North Plain plant fruit trees or vegetable crops, and the government has started building low flow irrigation to create large water saving. This is a large-scale technology and is suitable for a county or town water bureau with farming communities to share responsibility rather than following the traditional top-down method (Henry, 2004).

Comparing the use of ICTs in different countries

Because Chinese agricultural land is divided into small areas and each piece is supposed to be farmed by a single household, the farm areas just support small-scale production and restrict the development of modern technology (Zhao et al, 2007). Fortunately, farmers can rent land to industries or other farmers, and the farmers can

work outside of their villages. The farmers who rent large amount of land will rely on market direction or resources to adopt modern ICTs and develop an eco-agricultural production model to more benefits.

For sustainable agricultural development, food security is the most important consideration for Chinese farmers. As Deloitte (2012) indicates food security is more uncertain than ever and is focusing on agriculture and taking the first steps toward long-term development since the food is the essential factor of people's dietary and healthy life. Given the importance of ICTs in the agricultural development process, Deloitte cites ICTs contribution in Africa. Like the Chinese, small holders are the mainstay in Africa, who lack access to critical information, market facilitation, and financial services (Deloitte, 2012).

Deloitte (2012) used the ICTs such as computers, mobile phones or satellites to help small-scale farmers in Africa to address some of the issues and challenges they face and enhance their communication knowledge and services. According to Deloitte (2012), ICTs benefit four groups in the agriculture sector, businesses, farmers, researchers and governments. They use ICTs to share agricultural information in different farming steps. For instance, in pre-cultivation, the four groups can cooperate through ICTs to make crop/ land selection, calendar definition, even the irrigation conditions and management. The case study of using ICTs in Africa fully demonstrates the benefits of ICTs in agriculture and provides a good experience to developing countries. In China, there are more convenient conditions for using ICTs because the Chinese government advocates

the use of ICTs in agriculture and almost all Chinese farmers have the experiences of using mobile phones.

Not only in developing countries, developed countries like Canada also need ICTs to promote their environment and economy. The use of ICTs is encouraging behavioural changes (not only to farmers) in individuals and organizations (Wolfe & Bramwell, 2012). Canada has developed ICTs both in industry and agriculture to change market conditions. Canada focuses on training digital skills and Information Technology professionals (Wolfe & Bramwell, 2012). In a manner similar to what Canada has been doing with ICTs, China is bound to focus on developing ICTs and learning advanced models and skills from Canada, such as the one-to-many technology transfer approach, large-scale farming experience and efficient agricultural organizations.

Significance of the ICTs

Undoubtedly, ICTs greatly improved economic growth in developing countries. The role of ICTs is focused on reducing poverty and providing livelihood and empowerment (Development Co-operation Directorate & Development Assistance Committee, 2004). According to the studies of OECD (2003), ICTs had larger impacts on labour productivity than other types of capital; and combined capital and labour to develop multi-factor productivity and networking. In China, a small piece of land cannot support the whole family if the farmers are still restricted to conventional farming. They need to look for another job near the town so that they can give consideration to both farming and off-farm work. On the other hand, because of the differences between rural and urban

areas, more and more farmers are pouring into big cities and towns to be migrant workers. Almost 64% of the total population in 2000 registered in rural areas but live and work in cities (Heilig, 2003). In fact, few rural people work in agriculture besides women and old people. Such situations impel ICTs to improve development in rural areas.

Not only in the agricultural sector, ICT-based networking can also reduce transaction costs and accelerate innovation between rural-urban firms. ICTs investment can improve national economic performance and farmers' technological awareness. In addition, economic growth is more likely to be shown in societies that are healthier and better-educated, where individuals and communities have the skills and capacities to fulfill their potential development and to develop new business opportunities (DCD & DAC, 2004). However, to diffuse ICTs in rural areas, the communications infrastructure and services are very poor in many developing countries as well as China. One reason for this is that the government cannot invest in very remote areas. Another reason is the mountainous terrains which cannot open broadband or build communication facilities. Such situations require the government to create an enabling environment through ICTs investment for a long time.

The development of ICTs for large-scale agriculture

Given economic growth in agricultural areas, reducing production cost and management expenses through ICTs are the key factors in China. Therefore, the article also discusses if ICTs can effectively improve the farm-land in scale and agricultural production efficiency. In the agriculture process, economies of scale are decided by

management as part of a unit's business capacity. In other words, agricultural production's economies of scale rely on farmers' management (Cai & Du, 2009). The agriculture production took the family as the unit of production in China. According to Chen (2010), the collective ownership of land makes the benefits of production more directly linked to the labor of those who worked the land. However, the Household Responsibility System (HRS) encourages farmers to focus on their own benefit rather than their whole village or a wide range of areas (Chen, 2010). This is not beneficial for agricultural organizations and large-scale production. Moreover, the family farm structure is so small that it is not competitive, and very small farmers would rent out their land and rather work in the village industry (Heilig, 2003).

In fact, large-scale agricultural production is necessary, which is the key to raise the economic level especially for agricultural production. Generally, farm management is essential for production activity. For large scale farming to decrease management costs and transaction costs, the farm size and technology, such as land, energy, machinery and sales, modern management methods are needed through the help of ICTs.

As Cai and Du (2009) observe, under the restrained land-ownership, Chinese peasants obtain other 'contract land' which is very difficult, so the farmers may establish a labor income model of agriculture. The labor income model might farm land individually rather than using ICTs, which limit Chinese large-scale development. In order for China to develop large scale agriculture, according to Cai and Du (2009), the government needs to introduce the free trade of land to reduce the costs of obtaining more land for agriculture.

Fortunately, the Chinese government has understood the issue and now allows farmers or firms to rent large tracts of farming land and then rent it to individual farmers or cultivate it by themselves. In addition, China's government has encouraged provinces and counties to implement "land rights experiments" in a total of 18 national experiment zones for rural reform (Deininger et al., 2004). These experiments emphasize making land available for large-scale exploitation and giving households more secure land rights. This may reduce the costs of production and market costs. The results of the experiments showed that there was a huge improvement of income using more sophisticated technology with farmers.

Conclusion

This literature explores China's agricultural situation and economic reforms since 1990s. Furthermore, both the advantages and disadvantages of ICTs development in China were learned through the review. Through the readings, we also understand ICT methods have been an 'Information Revolution' sweeping the globe, and China has developed its rural agriculture since the 1980s. In 1950 the Chinese government was committed to increasing agricultural production and to developing sustainable agriculture in many rural areas. Although Chinese agricultural development still has many challenges, such as water shortage, food security, labour turnover, land loss and so on, through learning about other countries' experiences (Africa/ Canada) and the analysis of many researchers, the development and extension of ICTs is still the most essential issue in China. Moreover, developing ICTs in China requires fully understanding the Chinese

context and the village environment so that farmers can accept agricultural reform or structural changes, and then obtain new ICTs voluntarily. In order to be economically viable and socially acceptable at the village-level, the AII helped County-level pilot agricultural technicians' team building program to develop ICTs. Currently, experienced agricultural technicians in Miyun County have tried to improve farmers' access to agricultural information. The program would help farmers manage their agricultural production in pre-cultivation, crop cultivation and harvesting and post-harvest to reduce the production and management costs by ICTs. In the future, with the universal improvement of ICTs in China, the farmers will request more and more ICTs and then promote Chinese agricultural production in sustainable and large-scale ways, thereby raising productivity and reducing the need for so many people to work in farming. This in turn will enable more people, especially women, to become involved in other forms of production outside of agriculture, even while increasing everyone's access to high quality, fresh food.

Chapter Three: Research Methods

Introduction

With the rapid development of the ‘information revolution', using Information and Communication Technologies (ICTs), it has been widely argued that agricultural output and outcomes can be improved using these technologies (DCD & DAC, 2004). What’s more, in the global market, farmers have to use new technology; if they do not, competition with farmers who are using ICTs would eliminate farmers who do not adopt them or they would be forced to use these new technologies over time. According to ‘Village-level agricultural technicians team building program’ (2011) and ‘Rural practical and agricultural scientific talents long-term building planning’ (2010-2012) in China, the Agricultural Information Institute (AII) was determined to spread ICTs at the village level in rural areas beginning in 2011.

Because the Chinese have a different economic system and land policy from most countries in the western world, developing agricultural ICTs with Chinese farmers requires special ways suited to Chinese agriculture. The agricultural technicians, who are both farmers and agricultural technicians, are the most important bridge between these information technologies and less educated rural farmers. The agricultural technicians use 3G phones and laptops through the platform of the AII, guiding farmers to access new information and techniques in agriculture; furthermore, they also provide a monitoring service of agricultural products’ security.

Epistemological Approach

Both Kuhn (1970) and Popper (1993; 1999) believed that the purpose of research is

explanation and prediction of nature, but Kuhn's philosophy of science differs from that of Popper's.

Popper (1993) sought to show the philosophy from epistemology to ontology; his 'scientific realism' philosophy advocates deductive logic based on accepting or rejecting hypotheses which must be falsifiable. That logicist method could not identify how the substantive contents of scientific theories were reached and developed in Cruickshank's view (2007: 264). However, in the research of Miyun County, the researcher needed to deeply explore the ICT program and then test the theory inductively by observing events that occurred among stakeholders of the villages. Actually, Popper thinks that science depends on the process of the scientific method itself to leap forward, but Kuhn argues that science is readjusting from the framework to the paradigm and professional community (Hutcheon, 1995). For Kuhn, science progresses through paradigmatic revolutions.

The research in Miyun County was started with a hypothetical framework and then the researcher collected human experience in the certain context- Miyun County- to express the paradigm of using ICTs, and finally to control the consequence of using ICTs among rural farmers.

Kuhn's philosophy is post-positivist because it is based on what is directly observed and it takes into account the effects of causal laws (Cruickshank, 2007. P.271) but unlike positivism, it does not lay claim to absolute truth. Instead it recognizes that scientific paradigms evolve over time as earlier paradigms (normal science) are perceived to no

longer explain phenomena sufficiently. At that point, a new, post-normal scientific paradigm is required to better explain the perceived phenomena (Kuhn, 1970).

The survey was conducted in Miyun County to discover the capacities of farmers and how they will be affected by the implementation of the ICTs program. I used a case study to collect evidence to elaborate my research goal of determining whether the ICTs at village level are perceived to be improving farmers' capacities and each village's economy. This research was not capable of making an objective assessment of whether this has happened, in part because these ICTs have only recently been introduced; however, it has been useful in determining people's perceptions about whether improved productivity will be the result. When I collected the data, I tried to obtain more reliable data by interviewing farmers in various villages. The qualitative research and analysis explained how the ICTs impacted farmers' farming methods and gave farmers more knowledge about sustainable agro-ecosystems. This scientific epistemology is post-positivist, insofar as it employs methods which seek to be scientific despite the relatively small sample sizes which make generalizing to the larger farm and farm technician population unfeasible. Because I am using Grounded Theory (see below), even though I cannot make generalizations to the rest of China or even to the whole of Miyun County, I can, however, develop hypotheses which could be tested later with a larger sample.

Grounded Theory

To obtain valid data with internal consistency, multiple research methods were adopted.

My epistemological perspective is oriented toward cataloging participants' perceptions. For the survey, I utilized the Grounded Theory approach to collect and analyze the data. After surveying the professionals responsible for undertaking the pilot project in Miyun County, then the agricultural technicians implementing the pilot ICT project and finally the farmers targeted by the project, I used the grounded theory approach to analyze the data both by categorizing the responses through open and axial coding (see below).

My research only represented a small part of Miyun County rather than the whole county or throughout rural areas of China, limiting the generalizability of the results. Through the employment of the grounded theory method, every participant reported many incidents and answers to the open-ended questions. Open coding of all of the respondents' answers was conducted in order to identify themes which respondents commonly identified.

With open coding, the responses to each question are separated into mutually exclusive categories based on questions asked and comparisons made. The properties and dimensions of those categories suggested themes which were then percentaged to create tables (Strauss and Corbin, 1998) (see Findings chapter below).

Axial coding was used but grounded theory's Selective Coding was not used. Axial coding involves trying to consider the categories or themes developed by the open coding process in relation to the properties and dimensions of those categories. Therefore, it tries to see how the themes are linked together or are separated from each other (Strauss and Corbin, 1998).

The framework of the grounded theory in my research is shown below:

Research target identification ⟶ survey design ⟶

sampling ⟶ interviewing ⟶ open coding ⟶ axial coding

hypotheses generation ⟶ contingent explanation (subject to further replication)

Before I went to Miyun County, I obtained oral permission from Beijing Agricultural Information Institute (AII) and also the permit from Research Ethics Board (REB) of the University of Guelph. I identified my research goals and designed survey questionnaires for three levels: policy proponents, agricultural technicians and farmers. The samples included a total of 71 participants: 5 policy proponents, 34 technicians and 32 farmers. At each level for each question, I described the concepts through tables and diagrams specifically discriminating the data from the gender perspective. Thus grounded theory instructed me to use open and axial coding to analyze the information and findings from a post-positivist epistemological perspective.

Due to time constraints I interviewed parts of the three levels of people in Miyun County. The snowball method was adopted to obtain the respondents. After interviewing the participants, I conducted open coding by separating the data obtained from each question into mutually exclusive categories. I then used axial coding by comparing the responses among the different groups and at the different levels in the cases where the same questions were asked of the key informant policy proponents, the agricultural technicians and the farmers. This included, for example, presenting some suggestions that can improve the program, exploring the answers among the policy proponents, extension

workers and local farmers. Because the comparisons were restricted to Miyun County, the process of axial coding, as a technique to relate the themes that emerged from my open coding of the answers to the questions for the different types of interviews, was fairly straight forward. Selective coding was not used because the central category was about ICTs in the research and this could not be integrated as easily with all three participant levels.

Though the land does not belong to individuals, farmers have the right to maximally use the land and were free to say anything including rejecting participation in this research interview. Indeed, two farmers refused to participate in my interviews because they were too busy.

Research theories

One limitation of the snowball method is that in order to identify the appropriate person to participate in the interviews, the process is time consuming. Due to the involvement of the AII in making available the 3G platform for technicians and farmers, I interviewed four officials in the AII and one policy proponent in the Science and Technology Committee (STC) of Miyun County, who was recommended by officials of the AII. Then the official of the STC gave me part of a list of agricultural technicians of Miyun County. Since the agricultural technicians are usually professional farmers in the sense that they are experienced and educated farmers, they also constituted most of the farmers who are using ICTs. Even though there are 328 agricultural technicians in the

villages of Miyun County, I just visited 34 technicians and they each respectively recommended to me one farmer whom they served. The total number of farmers in Miyun County is 210,000.

Since the data required the three participant levels: policy proponents, agricultural technicians and local farmers, different open ended questionnaires were identified at each level even though many of the same issues were being studied from each participant level's perspective (see appendix 1-3). The questionnaires enabled me to collect more details about the participants and better understand the program. In the sampling survey design, the policy proponents were the AII director or personnel because they know more about this ICT program and could give me more national level information. With the agricultural technicians and the farmers, I focused on the farmers who used ICTs frequently and received assistance from technicians. This may have biased the results somewhat toward those who had a favourable view of the impact of ICTs on agricultural production so this is mentioned below under Limitations. Generally, the open ended questions were presented in very brief one-on-one interviews with the purpose of creating an overview of the program of persons using ICTs at different levels. All respondents participated in my survey voluntarily. The AII didn't know who participated in the survey and what they said. All participants were free to answer questions or withdraw at any time in the survey and their status was confidential as well.

I used a semi-structured interview method with both agricultural extension staff and farmers. The semi-structured interview method focused on two-way communication

between interviewer and interviewee. A relaxed atmosphere was important because Chinese farmers usually are working with the land or livestock and, they often don't have very good communication skills in formal occasions, especially for the open ended questions. Semi-structured interviews gave them a chance to talk to about their changes, problems and expectations with ICTs and the program. In the semi-structured interviews Ididn't collect the names of the respondents and instead used an alphanumerical label/identifier for all interviewees.

The policy proponents, agricultural technicians and farmers made a triangle in the survey. Through the use of triangulation method, I obtained comprehensive data and sources of information that provide valuable insights from different perspectives. The policy proponents in the AII and STC provided 3G platform and smart phones/ laptops to agricultural technicians in each village. Through the use of the ICTs, technicians learn new agricultural technologies and then instruct farmers to access new farming skills. The technicians also give feedback to the local STC and the AII by daily reports. As farmers are willing to get help from the technicians in the villages, the AII and STC should improve the program and then provide more support according to the feedback received. In fact, agricultural technicians are responsible to both local STC and farmers; they hand-on the knowledge and technologies to farmers and serve them.

In terms of the different groups, tables would be applied to illustrate the data. Because there were only 5 participants in the AII and the STC, in the analysis stage, few tables and more explanation were used for this group. On the other hand, due to the fact that

there were more participants at the agricultural technicians and farmers' levels (total 66 people), more tables were constructed for them than for the policy proponents' group.

The key informant interviews and a focus group method are used to analyze and identify strengths, weaknesses, opportunities and threats (SWOT) of the program. The key informant interview approach is a conversation to get specific information. With questionnaires, for the AII and STC personnel, the key informant interview typically lasted 40 minutes or more for each person and the participants were encouraged to describe their background or successful experiences in agriculture and how did they think they can promote the program further over time.

The key informant interview is a low cost and simple technique with flexibility and elasticity. During the interview process, however, the researcher might not control the time. That's the reason I designed different questionnaires for the different groups. In addition, according to various farmers' characteristics, I shortened or extended the interview time.

For the agricultural technicians, the questions were more focused on their operations with ICTs in the village, what their attitudes towards the project were and whether they thought about how to improve themselves and the farmers' capacities or the program at operational level. Furthermore, during the key informant interviews, farmers evaluated the agricultural technicians and presented various suggestions to the program. Simultaneously, the relationships among the program, agricultural technicians and farmers were revealed through this survey and this provides me with more confidence

with the results especially when the same result was encountered via the different methods with different groups.

For the same purpose of exploring the program, a focus group was used to discuss the project again and to explore further perceptions (benefits or problems of agriculture) with the participants. The method allows the interviewer to combine with participant observation to study participants and obtain different ideas in various social groups. The participants, including technicians and farmers, identified factual errors or extreme views and gave their perceived strengths, weaknesses, opportunities and threats (SWOT analysis) of the program.

Compared with the one-on-one interviews, the focus group method saves time and cost to get fairly intense feedback. There were 14 participants in the focus group including technicians, farmers and agricultural officials. They discussed current and potential opportunities of the program, how to use ICTs to organize and extend farming size, mechanization and marketing. Also, the focus group indicated both strengths and weaknesses of the program. With the agricultural experts I discussed how to enhance the use of ICTs in the village setting, which provided an opportunity for every participant in a setting and the respondents didn't feel isolated. What's more, the discussion in a group encouraged the farmers to develop deeper insights and come up with ideas they might not have thought of in a one-on-one interview.

I used the SWOT technique to analyze internal and external facts of the program: if the AII and STC provided the right training for technicians and if the technicians grasped the

new technologies and transferred them to the farmers (internal). The farmers also could point out the advantages and disadvantages while ICTs were used to/ help with agricultural activities, and showed potential opportunities or threats to farmers regarding both local and international markets. During the focus group discussion process, I encouraged farmers and technicians to address the problems of the program and their expectations about the ICTs. Through the discussion, participants provided more information and ideas to improve the use of ICTs in rural areas. Thirdly, in terms of the current marketing circumstance in rural areas, farmers wanted to find an easy way to set up organizations in villages with the help of the local government so that they can expand agricultural marketing and promote their produce and incomes further. However, the feedback that I collected from the focus group was only suitable for the context of Miyun County rather than being helpful in developing trends for analyzing general problems in other agricultural areas of China. Hence, researchers need to consider the change and development of the external circumstances, and then, in a timely fashion, adjust the SWOT matrix as required.

Through the survey of Miyun County, I gathered field notes more as a participant than as an observer; and then I collected data by observing as an "outsider" (getting data from an official list) and then by moving into the setting and observing as an "insider" (interview technicians and farmers to collect data). Following Creswell (2007) I kept a journal and analyzed public materials and official memos including the Village-level Agricultural Technicians Team Building Program (2011) and the Miyun quarterly

feedback system for technicians. This method helped to solve various problems of farmers, such as choosing effectively farming technologies or green/ organic fertilizers, etc.

Research Limitations

Any research method is influenced by the researcher's and participants' personal experience. At the same time, the data is too small to analyze using a statistical approach so that it cannot provide quantitative information which would enable generalization to all farming in the County. Also, because the agricultural technicians were the ones who identified the farmers that I interviewed, this may have biased the results somewhat towards farmers who would be more likely to comment favourably on the impact of using ICTs.

Finance and time were other limitations affecting the research. Miyun County includes vast areas such as mountains and plains so the limited money could not support me to visit the entire county. The survey was focused on the villages in the south and east of the County instead of northern and western areas. Farmers were also unwilling to spend more time to discuss their experience or business during the busy summer time. Furthermore, this research studied the phenomenon of the early stage that the program and ICTs were being implemented in Miyun County which was less than one year. For the whole project, however, it requires a longer term discovery and study to better understand the development and adjustment resulting from the use of ICTs with farmers. In addition, the

agricultural technicians cannot reach every household to teach them ICTs; and some farmers are only willing to use conventional ways rather than modern farming methods.

Summary

In the research, the post-positivist epistemological approach was used in combination with Grounded Theory survey techniques as part of the case study of participants' behaviour in Miyun County. The qualitative, Grounded Theory method framed the research process and informed the way in which the findings were analyzed. I employed open and axial coding methods from Grounded Theory but not selective coding so in this sense it was really a Modified Grounded Theoretical approach. The key informant and focused group theories well reflected the perceptions of the policy proponents and agricultural technicians. The semi-structured interview method enabled the researcher to get closer to the farmers and to learn their true thoughts about the program.

Though the research only explored the early stage of the program, I still collected relatively reliable and valid data and analyzed farmers' behaviour and expectations about the program. Thus this research will prepare future researchers to expand the survey samples and apply quantitative methods to test the hypotheses that I have developed.

Chapter Four: Research Context

Introduction

Due to globalization and market reform, China's Information and Communication Technologies has developed fabulously. China is undergoing rapid change and is developing its economy with significant technological approaches (Yu & Li-Hua, 2010). China is a predominantly rural country but the Government has recently paid more attention after 2006 on the Information and Communication Technologies (ICTs) for rural farmers' development.

ICT program and technicians in China

The agricultural extension system has been built by national government at provincial levels since 1990s, and then the provincial government assigned agricultural technical staff to agricultural extension agents in every county site. Previously agricultural extension technicians, however, were not playing their due roles. Too many agricultural extension people were reluctant to get into the field and talk to farmers. They were not fulfilling certain service targets and their extension tools were often backward. The work of every agricultural extension person was separated and the efficiency was undesirable. The main reason is that the local government didn't establish a monitoring system to supervise the process and these local departments were insufficiently integrated with each other. Another reason is that the agricultural extension staff paid more attention to earning their own money rather than serving individual farmers and hence the result was not very effective. Consequently, while making a transition to modern agriculture, China required

adaptable new extension technicians.

For the above purpose, developing and training agricultural technicians is the most essential issue in rural China where there is a widespread lack of agricultural technical expertise. The Agricultural Information Institute (AII) reformed this previous system by funding more money to equip the agricultural technicians with laptops and smart phones at the village level. The new agricultural technicians who were examined and selected by the local government and the local Science and Technology Committee (STC) belong to county level extension agents and they must directly help farmers in their villages. This situation is true throughout China in all four pilot rural areas, not only in Miyun County.

The development of ICTs in agricultural fields

Because of the large land areas and 1.3 billion populations of China, it is difficult for the government to spread one new project all over the country. The best way is to provide several pilot areas to develop and assign agriculture and then spread successful modes to other rural areas. A Ministry of Agriculture official said that the Ministry of Agriculture has revised the 1993 agricultural technology extension law on August 31st, 2012 and recognized the responsibility of Government and it has decided to inject more money into agricultural extension. The new law recognizes that developing modern agriculture needs to cooperate with other institutions in society. The Central government also launched projects to improve local agricultural extension in 2,600 counties and promote capacity development in 290 villages. What's more, the law indicated that agricultural programs intend to mobilize the enthusiasm of research institutions and agricultural businesses to

become involved in agricultural extension transitions and projects like the one I researched in Miyun County.

To further support the agricultural extension reform, the Chinese government launched the 'Village-level agricultural technicians team building program' (2011) and 'Rural practical and agricultural scientific talents long-term building planning' (2010-2012) to develop ICTs at the village level in rural areas. What the Ministry of Agriculture plans to do is to modernize agriculture and promote farmers to select advanced leading varieties for the marketing needs. In addition, to modernize and develop the agricultural extension system so that agricultural extension staff can involve/ help each household to expand extension services where each relevant authority is accountable. On the other hand, the Ministry of Agriculture also makes use of extension innovations, broadcasting, video, documentaries, hotline and modern technologies to improve service and productivity in rural areas.

The AII developed a 3G information platform program to promote agricultural technologies apply in Miyun County in September, 2011. AII is part of Chinese Academy of Agricultural Sciences (CAAS). Its scientific research fields are agricultural information technology, agricultural information management and agricultural information analysis. Under the promotion of the Ministry of Agriculture of China, AII helps local government and agricultural technicians serve farmers with ICTs. Apart from Beijing, the program also started in Jiangsu, Henan and Xinjiang provinces of China (Yang, 2011).

In view of the circumstance in rural villages that farmers are less educated than

urbanites, an increasing number of young villagers give up farming to work in cities. The average farmers in rural China are about 45 years old and they are not well knowledgeable about modern social technologies or media. Continuing education is often inadequate to address their shortcomings, especially for old farmers or farming activities which need practical experience. To solve this problem, the Chinese government needs to depend on agricultural technicians to transfer new ICTs to farmers. Developing and training agricultural technicians is the most essential issue in rural China where there is a widespread lack of agricultural technical expertise. In order to provide new information and techniques to every farmer, Beijing government was planning to allocate agricultural technicians to every village in which are over 50 households in Miyun County. The AII developed the 3G information platform in this County to test the use of smart phones and notebooks by technicians to improve farmers' access to agricultural information. Up to now, 328 agricultural technicians are employed for the post. As part of the pilot project they were equipped with 3G phones and laptops guiding farmers to access agricultural information and new techniques; furthermore, they also provided monitoring service for the security of agricultural products.

The ICT program in Miyun County

Miyun County is located in northern Huabei Plain of China and has various topographies such as plateaus, mountains, basins, plains, and oceans (Wang. & Tang.). Miyun is one of the counties of Beijing; it is also one of agro-ecological pilot counties in China. Miyun County is located in north-east of Beijing - the capital of China. The total

area of Miyun County is 2229 square kilometers with 468,000 people. There are 210 thousand farmers, 44.9% out of the total population (468 thousand) in Miyun County (sixth national census data, 2010). Miyun Reservoir is in the centre of the county to provide water to Beijing. Because of the unique geographical conditions, agriculture, forestry, husbandry and fishery are all developing in the County. There are 152 agricultural sightseeing gardens which provide 102 million Yuan (1 Yuan = 0.6 Canadian Dollars) for one year to the farmers (sixth national census data, 2010). In terms of agriculture, the main farm commodities in Miyun are wheat, corn and vegetables, etc. Relatively speaking, there are sophisticated technologies and agricultural experiences than in other counties of China; hence, the AII develops Miyun County to test the use of smart phones and notebooks (ICTs) by technicians to improve farmers' access to agricultural information.

In Miyun County, though farmers have adopted the very best seeds, green fertilizer and pesticide to improve produce, they are eager to obtain more instructions on pest management, updating planting techniques and changing conventional farming methods in the light of the market needs. To improve the yield, the government also encourages farmers to adopt ICTs and organic fertilizer on their crops instead of chemical pesticides. Moreover, the people around 40-50 years old are the dominant laborers in the rural areas because most of younger people prefer to have jobs in cities rather than in a village. Such farmers learning new techniques are slow and have less chance to access ICTs on farming. They don't understand how to run a business but produce according to conventional

habits instead of updating their methods of planning. In this conventional way, farmers used to adopt lower cost chemical fertilizer or pesticides in order to achieve benefits immediately. In addition, few technicians taught farmers how to access advantageous techniques in the small villages.

Farmers don't own the land in China. The land policy has remained as collective property in China; farmers only sign 30-year leases for the right to work a plot. They can't sell it and can't use it for collateral on a loan (Zweig, 1997). Such land policy allows farmers to have the rights to use land but not own it. This makes farmers consider only short-term benefits and overuse natural resources rather than protecting the environment and maintaining long-term effects such as raising sustainable agriculture or the balance of the whole living environment.

To some extent, although the land policy in China limits farmers' extension, farmers still can use their land for a long time (from a generation to the next generation) if the next generation is still registered in rural areas and be villagers. Not surprisingly, with rapid economic development and population growth, more and more transport roads and residential properties occupied large arable land, there is only 1.33 mu (1 mu =0.16 acre) per person (Chinese official statistics, 2010) in China; the agricultural land is being steadily reduced. The rise in land price leads to the high-cost of farming; hence, reducing costs and developing agricultural large-scale production and centralized land management are imperative strategies to save Chinese natural resources and ensure food supply. As more large scale and cooperative farming are urgently needed, new knowledge of

large-scale farming methods and techniques require agricultural technicians to be equipped.

Conclusion

For the development of the ICT program in the context of Miyun County, the AII needs the support of the STC to monitor and get feedback. The management of agricultural extension needs improvement to evaluate the performance of agricultural technicians as well. 3G information platform (from AII) has been applied for agricultural extension of agricultural consulting, expert consultation, marketing, agricultural information, training, logging and dynamic scheduling. For China's agricultural innovation, the Knowledge Translation and Transfer (KTT) approach of Ontario, Canada, might improve information flow to Chinese farmers. However, the agricultural and environmental system properties need a long time to be maintained and developed. Thus, to improve farmers' knowledge and awareness about sustainable agriculture and efficient production are the main points of this program in Miyun County.

Chapter Five: Research Findings

Introduction

This chapter presents the data from interviews that were conducted with five key informants, 34 agricultural technicians and 32 farmers in Miyun County, less than two hours from Beijing.

All the participants' answers were separated to the various different questions into mutually exclusive categories using open and axial coding methods. For each question, I categorized the combined responses of each participant of the total 71 people into the themes or categories in the tables. A grouped response to each question is therefore put into a theme and the number of responses that were similar. Each of them were then percentaged out of the total number of participants who answered each question so that the most popular themes could be distinguished from the less popular themes. For instance, in Table 10 (below), I classified the agricultural technicians' experience into this table. There were five items illustrating workers' experience from agriculture to market, etc. By showing the experience of the group, we can clearly see how the agricultural technicians' various experiences were classified into different items and we also can see the number and percentage respectively.

In the following analysis of the tables, the axial coding method was only used a little bit so far this reason this is really a type of modified grounded theory as it also doesn't include selective coding. For every category, when I analyzed the findings, because some data were not relative to the framework (someone had no response or the answers were invalid), I explained some phenomena which were relevant to the theme. For example,

ninety-seven percent of the technicians have agricultural experience (table 10) and 47% (table 11) of the technicians thought that solving practical farming technological issues were more important than protection of the environment. Moreover, one hundred percent of the agricultural technicians were willing to use the 3G platform and ICTs in the future (table 12) and 91% of local farmers had learned the agricultural knowledge from the technicians (table 30). Those data showed that the ICTs have become an important tool for farming activities in Miyun County, but the awareness of sustainable agriculture is not developing much at the moment.

Key Informant Interviews

Policy proponents

The research began by interviewing five members of the policymaking bodies: four from the Agricultural Information Institute (AII) and one from the Miyun Science and Technology Committee (STC). Table 1A and B show their age, gender and educational composition.

Table 1.The Gender, Age and Educations of the Five AII Proponents

Table 1-A. The gender and Age of Policy Proponents

Age	**Male**	**Female**
Under 40-year-old	2	0
40-50-year-old	1	1
Over 50-year-old	1	0
Total	4	1

Table 1-B. The gender and Education level of Policy Proponents

Education level	Male	Female
Under graduate	1	1
P.H.D	3	0
Total	4	1

From table 1, we can see that males occupied the main positions, decision-maker level and the only female is from Miyun Science and Technology Committee (STC), not the Agriculture Information Institute (AII). Their ages are around 40-50 years old. All of them have higher education backgrounds, none with less than an under undergraduate degree. Table 2 shows their work experience

Table 2. AII Professionals' Work Experience (multiple answers given by individuals)

Item	Experience	Number
Agricultural	Rural information development	5
Policy	1.Policy implementation	5
	2.Agricultural information technology proposals	2
	3.Agricultural market supply and demand	2
	4.ICTs' impacts on rural farmers	2
Political	None	None
Any other	ICT skills	2

For this question, there were various experiences given by the AII and the STC personnel because each of them gave more than one answers. Both AII and STC are committed to developing ICTs in Chinese Agriculture. The people who are in AIRI are only concerned with agricultural field and implement the policies rather than making decisions. Due to the different work divisions, some participants focus on agricultural production and market development, others concentrate on improving the use of the 3G platform in farming activities. Such experiences lead the AII to contributing professional

support to rural ICT development. Table 3 shows the mandates of the Agricultural Information Institute (AII).

Table 3.Mandates of the Persons at the AII (multiple answers given by individuals)

Mandate	**Number**
Spread and promote ICTs on agriculture	4
Public Service	3
Develop/research agricultural electronic information	3
Provide library resource	3
Agricultural innovation research and personnel training	2

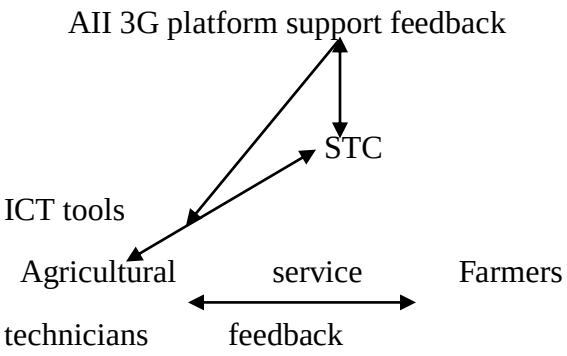
In table 3, because of the different duties in the AII, the mandate is different as well. One person usually gave two or three answers for the question. Four people answered the question, and all of them believe the institute is not a decision-making body but its purpose is to spread and promote ICTs with agriculture in rural China. According to the table, the AII is committed to develop ICTs innovation and public service to rural farmers.

The AII is a research institute and performs its duty to develop agricultural information technology according to national plans. It cannot make or influence policy or project decisions. Sometimes, some members of AII will help and draft national projects but they don't have economic or political relationships to the project decisions.

Since policy decisions are made on the national level and only two people believed that some scientists give suggestions to policy decisions. The technicians provide advice as a project occurs. One person, the sub-director of the AII, indicated that farmers also can

give their suggestions to AII. However, another two people thought that policy decisions are top-down, and none of them make decisions. Thus scientists, technicians and farmers are usually not involved in making decisions.

Figure 1. Relationships among the AII, the Agricultural Technicians and Farmers



The figure above illustrates the relationships between the AII, the agricultural technicians and farmers. Obviously, because the project was performed in Miyun County, the STC of Miyun also held a positive role, as the 3G platform and smart phones/ laptops and feedback collection are applied by the STC. The AII provided the 3G platform and technology. Regularly, it collects feedback from STC, technicians and farmers to improve the use of platform and ICTs. However, only one participant who is in the AII argued that the AII services agricultural technology development rather than training farmers which should be taken by the local government. Instead, all of the participants believed that the agricultural technicians are mainly responsible for farmers. The agricultural technicians service farmers. They have mutual relationships in the project.

The local government and STC provided training for agricultural technicians. The technicians were selected from local villages, so the local training is very important. The STC officer listed several training contexts which almost included all agricultural aspects. Agricultural technicians can choose different agricultural courses according to their own agricultural fields, such as crops, fruit trees or vegetables, in the training system. They usually can learn agricultural policies, technologies, insurance and market knowledge from the training courses. Table 4 illustrates the perceptions of the AII and STC about the training.

Table 4.Perceptions of the AII and STC Personnel about the Training Courses

Method	**Number**
Add new training courses over time	2
Provide financial support by Beijing government	1
Don't know	1
Searching on line through information tools (phones or laptops) by farmer themselves	1

Actually, the AII does not have the duty of training personnel and it is the STC of Miyun County that does. The sub-director of AII and the officer of STC indicated that training courses will change over time due to the different seasons. Others thought that the Beijing Government will allocate funds, and technicians will learn new technology or information through the 3G platform or on line; one person did not even know about the training in Miyun County. Table 5 shows reasons for selecting Miyun County as a pilot.

Table 5. Reasons for Using Miyun County as a Pilot Project (multiple answers given by individuals)

Item	Reasons by number		
The technicians are more able, average or less than average compared with other Agricultural Counties.	Able 4	Average	Less
The agricultural environment is stronger, average or less than farmers in other Counties.	Stronger 3	Average	Less
It is a more productive agricultural area than elsewhere.	Higher	Average	Lower 2
The farmers are more productive, average or less than average.	More 1	Average 2	Less

Because each participant answered all questions, they provided multiple answers for the question. Compared to other agricultural areas, Miyun County is no more productive agriculturally; however, there is strong support from the local STC, and the technicians are willing to learn new information and help farmers. Another reason is Miyun County is one of the agro-ecological pilot counties in China where the farmers have higher awareness of sustainable agriculture.

The project employed technicians to focus on agricultural experiences and learning ability rather than on education or training. This is because if the technicians have good learning ability and have rich farming experience, they can efficiently grasp new knowledge and then help farmers in their local contexts. The STC also applied exams for candidates to select agricultural technicians.

Compared with other districts, farmers in Miyun County have used organic or green fertilizers in crops more often; moreover, due to the fact that it is near Beijing, there are more forms of financial supports and job opportunities in Miyun County. The farmers are

richer than other farmers who live in nearby other provinces' counties. Some farmers develop agricultural tourism projects, and some farmers work for the government to manage natural resources, such as rangers. Miyun reservoir is the source of drinking water for Beijing so the fish farming is more advanced than in other districts. Similarly, with the economic development, more and more farmers go to Beijing to be migrant workers.

Except for one participant who didn't respond, all of the proponents believed that the project is going very well. One official thought it is an innovation from theory to practice, especially the log reporting form on the 3G platform which provides a platform to let agricultural technicians or experts exchange their information and experience. The agricultural technicians are like a bridge between the government and farmers. They not only transfer new technologies to farmers but also report agricultural problems to AII in a timely fashion. They have obtained farmers' trust as well.

The question about whether the agricultural production outlook is different with agricultural technicians' help was not on the STC's questionnaire, so there were only 4 people who answered the question. All participants thought that agricultural production will be improved with technicians' help since the agricultural technicians can find practical problems and solve them quickly. Technicians have the efficient platform (3G platform) and tools to exchange information and experiences so farmers can meet specialists to make their information technology-based farming.

The policy proponents were asked their expectations about the long term impacts of the program and the results are shown in table 6.

Table 6. Expectations of the AIRI Personnel about the Long term Impacts of the Program (multiple answers given by individuals)

Item	Number
Spread the mode to more counties and villages	2
It solves practical problems	1
It is a good mode and bridge to report and solve agricultural production and market problems	1
Promote agriculture development and information exchange	1
Provide experts team to serve farmers' production and sale	1

For this question, the participants also gave multiple answers. According to the responses, we can see that both the AII and the STC hoped that the program can bring outstanding impacts for the long time in Miyun County. They also expected the program to be successfully spread to more rural areas of China and help more farmers.

For large-scale farming and organizations, all participants thought it is a support role to aid farmers obtaining more advanced agricultural ICTs so as to improve agricultural production gradually. The use of ICTs is still the essential method on modern farming activities. One participant pointed out that ICTs can reduce production costs; and another official said it can push farmers to learn advanced information and technologies to meet marketing needs. One of participants indicated that the use of the ICTs would gradually improve the awareness of environment and large-scale farming. Table 7 illustrates the changes affecting the ICT program.

Table 7. Changes that Have Occurred in the ICT Program (multiple answers given by individuals)

Item	Number
None	2
A platform to exchange information	2
Agricultural expert team has been set up	1
Farmers' own capacities have improved	1

In terms of the changes, only two people didn't know the details because they just focused on ICTs and 3G platform promotion. Other participants, especially the sub-director of the AII, indicated that setting up a professional experts' team helped farmers improve their farming capacities and enlarged the use of ICTs and information exchange. They named some examples of the change. Typically, in a village, some farmers' walnut trees of around 16 acres suffered from a disease which the farmers had never seen. In the past, the farmer just bought a pesticides or cut the trees down which would reduce their production and income. Fortunately, now, the agricultural technicians could report the problem to the 3G platform in time, and then the government can decide to invite experts to provide training and treatment methods to farmers.

Except for two participants who didn't respond to the question about how one can improve this ICT program, one policy proponent replied that at present, the program is developing positively. Continuing to develop the current platform and project is thought to be necessary. Other people indicated that if the national government can provide more financial or policy support, the project will develop faster and offer more ICTs and technicians to help agriculture improve in the future, such as settling sustainable or large-scale agriculture in more rural areas. Table eight reveals the other ways of improving the program according to the AII and STC key informants.

Table 8. Feedback by the AII and the STC Personnel Regarding the Importance of the Program (multiple answers given by individuals)

Item	Number
Intensify ICTs use and improve farmers' information	2

capacities	
Develop cooperation with other countries to learn large-scale experience or share ICTs	1
Enhance agricultural insurance to give farmers production guarantee	1
Set up local production information on the platform to enlarge supply/ demand market	1
None	1

It can be seen from table 8 that the use of the ICTs is perceived by the informants to be the key method to develop agriculture in the future. ICTs will contribute to improving agriculture in all stages from land production to marketing produce.

Agricultural technicians' perceptions about Using Information and Communication Technologies for Agricultural Extension

Thirty-four agricultural technicians (extensionists who are advanced farmers) provided the following responses to questions that were asked. The technicians' responses were separated into mutually exclusive categories using open and axial coding methods, then tables were constructed of those categories and the responses were given as persentages. Sometimes one participant gave more than one answer for the open-ended questions so the percentages may add up to more than 100%.

To explain why the percentages often add up to more than 100% below, look at Table 10. There were 34 agricultural technicians of whom 33 were in agriculture (97%) and 1 with other experience (3%). Yet 15 had experience in marketing as well (44%), 6 in village affairs management (18%) and 2 depended as well on local government work (6%). So the total is 168%, not 100%. The same applies to the questions that were coded

into open and axial coding. The totals may exceed 100%. Regarding the findings, I described the properties and dimensions in percentages below. Table 9-A and B present some of their demographic characteristics.

Table 9. Demographic Characteristic of the Agricultural Technicians

Table 9-A. Ages of the Agricultural Technicians

Age	**Male**	**Percentage**	**Female**	**Percentage**
Under 30-year-old	1	3	0	0
30-40 years old	1	3	7	21
40-50 years old	5	15	10	29
50-60 years old	7	21	2	6
Over 60-year-old	1	3	0	0
Total	15	44	19	56

Table 9-B. Education Level of the Agricultural Technicians

Education level	**Male**	**Female**	**Total Number**	**Percentage**
Junior high school	1	0	1	3
High school	9	13	22	65
Vocational high school	4	4	8	24
College	1	2	3	9
Total number	15	19	34	101

There were 19 females of the 34 agricultural technicians, 56% females are playing key roles helping farmers in Miyun County. The ages of most technicians are around 30-60 years old. Only one male participant is under 30-years (26-year-old) and one man is over 60 years old (60-year-old). Most females are between 30-50 years old, especially having the ages of 30-40 years, 6 more than men's ages. Technicians of around the ages of 40-50 years with experience and good learning abilities are common (15 people) in this program. Similarly, through the table B, we can see that the agricultural technicians generally accessed higher education. Most of them graduated from high school (65%);

only one technician was in junior high school but he has rich agricultural experience and organized his villager to develop large-scale production in 7 years. In addition, there were more females (13 people) who graduated from high school compared with males (9 people). Table 10 presents their experience.

Table 10. Experience of Agricultural Technicians (multiple answers given by individuals)

Item	**Male**	**Female**	**Total number**	**Percentage**
Agriculture	15	18	33	97
Marketing	8	7	15	44
Village's affairs management	3	3	6	18
Depend on local government to work	2	0	2	6
Any other	0	1	1	3

There was only one person who worked in a cloth factory before she became an agricultural technician, and others have rich farming experience either on field crops, vegetables or fruit trees. Therefore, to be an agricultural technician requires rich agricultural experience but not the skills of using smart phones or laptops or any other ICTs. Although only 44% of the technicians had marketing experience, and two male participants still relied on local government to take on the production, the agricultural technicians had understood that it is the market that is an important link with the development of the program. More and more technicians are eager to set up efficient organizations in their villages to solve agricultural products supply/demand issues when they heard other technicians did excellent work on marketing. Only 6 technicians take part in the village affairs management (under 19%). Obviously, the local government

affairs management is not in direct contact with agricultural technicians' activities. Table 11 reviews what the agricultural technicians believed they are expected to do with farmers.

Table 11. Perceptions of Agricultural Technicians on Expectations of Farmers (multiple answers given by individuals)

Item	Number	Percentage of total responses
Solve practical technological issues	16	47
Pest control/fertilizer use	13	38
Select seeds	7	21
Distribute farming notices	7	21
Work with farmers in fields	6	18
Assist in marketing	5	15
Answer farming challenges	5	15
Assist to improve production	3	9
Protection of the environment	1	3
Train farmers	1	3

For this question, technicians provided more than one answer and that's why the percentage is greater than 100%. In terms of the work of agricultural technicians, most of them focused on solving practical farming technological problems and pest control/ fertilize use. Also, almost half of the participants believed that selection of seed is another key factor to improve production. Quite a number of technicians often go to the fields to find farmers' practical problems and solve/ report them in a timely fashion. Generally, technicians use broadcasting to broadcast new agricultural notices or warn farmers to take precautions. Though only one technician mentioned the vegetation protection and training farmers to improve their own capacities respectively, I believe that with the development

of the program, more technicians will realize what the issues are. On the other hand, although some technicians do all of the above things, there are still two people who said there were enrollment problems on the platform or said that answering the questions of farmers are training issues.

The survey shows that the local STC provides almost all training courses to agricultural technicians about both agricultural information and production from new technologies to various issues related to planting fields. However, two technicians indicated that there are no 3G phones for use in training because it is a simple tool. Agricultural technicians will be trained to link to their work fields but the technicians do not take all of the courses. For instance, one technician thought he didn't need the training for the information application. Table 12 shows the farming techniques that the agricultural technicians believed is expected by the government.

Table 12. The Perceptions of Technicians on Farming Techniques which They Believed are Expected by the Government (multiple answers given by individuals)

Item	**Number**	**Percentage**
Use of 3G platform/ICTs	34	100
Typing skills	9	26
Write emails or logs	8	24
Internet search skills	5	15
Internet communication skills	1	3
Usage of cell phone to upload information	1	3

The participants gave multiple answers to this question. As can be seen from table 12, skills using the 3G platform and ICTs are the most highly expected skills (100%) by the technicians as well as by the government representatives (AII and STC). They hope to

grasp more modern technologies and knowledge to improve themselves and the farmers. Also, they have realized that the ICTs are essential tools for them to compete with other farmers. Table 13 shows the types of communication tools of farmers by the number of villages as perceived by the agricultural technicians.

Table 13. Number of Villages in which ICT Tools are Available (multiple answers given by individuals)

Item	Village number	Percentage
Cell phone	34	100
Computer	32	94
Internet usage	29	85
Telephone	27	79
3G phone	9	26
printer	6	18
TV internet box	1	3

Because there are more than one communication tool for people, the total numbers were over 34 villages. In each village, telephones and cell phones are popular communication tools. However, an increasing number of villagers have rescinded the use of telephones and instead are using cell phones because it is convenient and cheap (100%). Few farmers have 3G phones except the technicians because it is slow to access the Internet. Another reason is that 3G phones are too complex for farmers. For the same reason though there are computers in most of villages (94%), many people use them without broadband service because of the mountainous terrains and weak network signals. Similarly, the Internet usages are not universal in the villages. Several villages have printers; usually one printer is put in the village office. Only one technician has a TV

Internet box to see the agricultural channel. Table 14 presents the number of problems perceived by the agricultural technicians.

Table 14. Number of Technicians who Encountered Problems when Introducing Technologies to Farmers

Item	Number	Percentage
Need new agricultural skills	13	38
No problems	7	21
No advanced training courses	5	15
Weak signals of the internet	4	9
Usage of ICT tools	3	12
Extension of new varieties	2	6
Market information	1	3
Farmer's receptivity	1	3

With the development of the program in Miyun County, agricultural technicians were faced with many problems when they provided information or introduced technology to farmers. Thirty-eight percent of the technicians said that lack of new technological knowledge was the foremost problem. More and more technicians preferred to learn efficient information on-line to solve problems by themselves. Some technicians believed that they could use ICTs to solve most issues. Apart from problems of the technicians themselves, the weak signals also hindered technicians while using ICTs to provide information or introduce new skills to farmers.

The number of technicians who improved their capacities is presented in table 15.

Table 15. The Number of Technicians who Improved their Capacities (multiple answers given by individuals)

Item	Number	Percentage
Agricultural knowledge & experience	24	71
The use of ICTs	9	26
Communication skills	8	24
None	2	6
Interpersonal skills	2	6

Since the technicians who improved their capacities in various fields, the answers were multiple. With the help of ICTs, technicians' agricultural knowledge and experience increased rapidly. Most participants (71%) thought that their knowledge was improved. About one quarter of the technicians thought their communication skills and the abilities of the use of ICTs improved. Only two people believed that there were no changes of their capacities after using ICTs. The kinds of farmers who preferred to use ICTs are presented by agricultural technicians below.

Table 16. Perceptions of Technicians on their Farmers Regarding the Preference, Access and Use of ICTs (multiple answers given by individuals)

Item	Number	Percentage
All farmers	11	32
Rich farmers	6	18
Poor farmers	2	6
Higher educated farmers	4	12
Less educated farmers	2	6
Male farmers	6	18
Female farmers	7	21
Younger farmers (under 50-year-old)	9	26
Older farmers (over 50-year-old)	9	26

Most farmers were willing to learn agricultural knowledge by using ICTs. Basically, there were no big differences in villages where farmers accessed ICTs. In some villages, the richer farmers prefer to access ICTs since they wanted to further improve their

production. In some villages, the poorer farmers also wanted to obtain more information to raise their incomes. Similarly, younger farmers preferred using ICTs because they don't have enough agricultural experience, and needed technicians' help. What's more, they found it is easy to use ICTs. Another reason is that there were more female farmers and older farmers in the villages so the numbers were higher. It also showed that farmers with higher education are more likely to use ICTs than the less educated farmers. The perceived outcomes that the technicians believed resulted from the use of ICTs are presented below.

Table 17. The Perceived Outcomes as Expressed by the Technicians from the use of ICTs Promoted by the Project (multiple answers given by individuals)

Item	**Result**	**Number**	**Percentage**
Yields	Higher Lower	23 1	68 3
Quality of crops	Higher	22	65
Diversity of production types– if so, what are they?	New varieties	13	38
The use of the chemical fertilizers, pesticides, increase or decrease?	Organic No pollution	2 18	6 53
Status of the incomes of farmers	Higher	23	68
Social issues/ mobility?	More farmers	4	12
No response		2	6
No change		1	3

Almost 68% of the technicians thought that the yields and income increased obviously by the use of the ICTs because most technicians believed that the yields are equal to farmers' income. Simultaneously, with the improvement of farmers' technologies, they

believed that the quality of crops improved as well (65%). In Miyun County, farmers usually apply no chemical fertilizers and prefer to use organic fertilizers. With the development of the program more and more farmers reduced their use of chemical fertilizers. Several technicians believed that the farmers experienced more social mobility; some of them thought that the village mobility is steady and more people prefer farming in the villages than before. Table 18 describes how the technicians said the information was transferred to the farmers.

Table 18. Methods used by Technicians to Transfer Information to the Farmers (multiple answers given by individuals)

Item	**Number**	**Percentage**
Demonstration in farmers' fields	32	94
Broadcast of information by amplifier	12	35
Farmers visit technicians	4	12
Information by paper	2	6
Instruction by groups	2	6
Cell phone use	2	6

Because the agricultural technicians adopted various ways to transfer information to farmers, the responses were multiple. As we can see from the table, technicians applied many ways to transfer the information or techniques to farmers. Going to farmers' fields and demonstrating the technology to farmers are common methods. However, there were two technicians waiting for farmers to come and solve their problems. This is also a way of solving problems in a timely fashion. Generally, agricultural technicians provide some common agricultural knowledge or knowledge of diseases to warn farmers through broadcasting (35%) by amplifiers. In addition, some technicians instructed new skills or

information to farmers by groups to save time and work or they solve problems in the village organizations. Others collected frequently asked questions on a paper and then sent it out to farmers. Commonly, the agricultural technicians use ICT tools to find solutions from experts or the 3G platform; however, two technicians used ICT tools to solve problems on the phone. They asked farmers what problems they have by using the phones and then they give them solutions or go to check or ask experts to solve them. This is a better manner to get the best benefits of ICT tools. The ability to accept ICTs by farmers and their attitudes to agricultural technicians are presented in Table 19 (A &B) below.

Table 19-A. The perceptions of Technicians on the Ability of Farmers to Accept ICTs

Item	Range	Number	Percentage
Ability to accept	Acceptable	18	53
	Higher	7	21
	Too old to accept	5	15
	Seldom	2	6
	None	2	6

Table 19-B. Attitudes of Agricultural Technicians Regarding the Farmers

Item	Range	Number	Percentage
Attitudes to technicians	Higher	11	32
	None	9	26
	Ordinary	8	24
	Compare to other information	4	12
	Lower	2	6

In the view of the agricultural technicians, most ICTs (53%) are acceptable for farmers and 21% of the technicians believed that the farmers have higher ability to accept new ICTs. Some technicians said old people could not accept new ICTs immediately. Generally, farmers have good abilities to accept the ICTs in most villages; however, there

were still 4 technicians who said that it is hard for older farmers to accept ICTs. Those farmers don't want to change their conventional farming habits instead of using ICTs to adopt new farming methods. More agricultural technicians (32%) reported that the extension workers have a good reputation in their villages. Farmers relied on them when the farmers have any farming problems, but 9 technicians didn't answer the question. Twenty-one percent of the total technicians thought farmers were willing to ask about agricultural issues from them, but some farmers would wait for a while and compare the information or technology and then decide whether to use the new skill or new varieties.

Agricultural technicians also responded to the question about whether they believed that ICTs will improve farming and the perceptions of technicians whether the program has met China's agricultural needs (Table 20 A-B).

Table 20-A. Perceptions of Agricultural Technicians Whether ICTs will Improve Farming Productivity

Item	Number	Percentage
Yes	31	91
No	2	6
No response	1	3

Table 20-B. Perceptions of Technicians Whether the Program has Met Agricultural Needs

Item	Number	Percentage
None	27	79
Need improve further	6	18
Meet the needs	1	3

Except for one agricultural technician who said he didn't know the answer to the question, most of the technicians (91%) believed that ICTs will be important in long term farming productivity and social mobility. Because the ICTs improved farmers' production and planting techniques and reduced the use of pesticides, technicians hoped ICTs can further strengthen farming and become popularized with the farmers specifically in large-scale farming activities. Two agricultural technicians thought the ICTs are not very important compared with practical experience. On the other hand, 18% of the technicians thought that the program needs to be improved over time and one person believed it has met the agricultural needs; but there were a large number of participants who didn't respond to the question.

Agricultural technicians as information terminals presented their experiences as below.

Table 21. The Fields of Expertise of Agricultural Technicians

Item	Number	Percentage
Pest control	19	56
Communication skills	5	15
New varieties	3	9
Improved technologies	3	9
Marketing	2	6
General	2	6

Most agricultural technicians (56%) pointed out that the most efficient experience with ICTs is pest control. One of the technicians said he had used walnut leaves as fertilizer, but after he applied the 3G platform as an agricultural technician, he knew that using walnut leaves can cause an increase in pests. He immediately changed the method and transferred the information to other farmers so as to improve their yields. In addition,

quite a number of technicians (15%) indicated that their communication skills and agricultural techniques (9%) improved, and more farmers dared to try new varieties with the help of the ICTs. There were still a few technicians using the ICTs to develop markets; however, in the survey, it was shown that some technicians and farmers have these same intentions.

The agricultural technicians pointed out how they solved the problems of agricultural marketing by using ICTs and their perceptions on the contribution of the program to agricultural improvement are shown in table 22A and B.

Table 22-A. Technicians' Responses to Solving Marketing Problems of the Farmers

Item	Number	Percentage
Collection of produce in the village	11	32
Rely on the 3G platform/ internet	9	27
Technicians assist in marketing	6	18
Sales by village or organizations	5	15

Table 22-B. Technicians' Perceptions on the Contribution of the Program to Agricultural Improvement

Item	Number	Percentage
None	21	62
Extend planting scale and diversity	8	24
Set up village organization	4	12
The role of the bridge	1	3

Through the program and the use of the ICTs, farmers liked to raise their related crops or trees planting to promote their production. This trend was obvious in vegetable fields. Therefore, 24% of the participants of the technicians pointed out that the program contributed to the planting diversity and scale extension. More and more farmers (12%)

preferred setting up agricultural associations in the village to better manage their production and sales and develop agricultural construction towards large and technology-based production. There are still problems in agricultural marketing in Miyun County. Farmers' yields usually are taken by small businesses or individuals who go to villages to collect products directly from farmers' land. Some farmers (27%) relied on the 3G platform or the internet to search big markets, and some of them ask the agricultural technicians to help to expand the market. Only 15% of the technicians said that farmers sell their produce through the village associations. Though those farmers occupied small percentages at present, this is an efficient marketing method for increasing production, since at the organization level, technicians find it easy to negotiate a good price for farmers. On the other hand, organic vegetables and products are always in short supply; the farmers didn't need to worry about the market at all. Table 23 illustrates what the agricultural technicians undertook as their responsibilities during the program so as to balance their duties between the local government and the farmers.

Table 23. Response of Technicians on the Balance of their Duties to Local Government and to the Farmers (multiple answers given by individuals)

Item	Number	Percentage
To the government:		
Daily report	21	62
Find more subsidies	1	3
Learn new knowledge	1	3
To the farmers:		
Go to farmers' field	24	71
Be a call person	3	9

The AII and the local government have the quarterly feedback system to evaluate the work of agricultural technicians and require agricultural technicians to upload their daily reports to the platform so that everyone can see the information or problems about farmers. There are only 62% technicians who mentioned the daily report in the survey, but the government requires everyone to send logs every day. Because of the help of the ICTs and the technicians, some farmers' farming sizes are becoming extended. The government prefers to give more funds to farmers who have bigger farm sizes so that 3% of the total technicians initiatively sought more subsidies to farmers. Three percent of the technicians realized their own inadequacies to learn more technological knowledge or got more training courses. For farmers, most technicians (71%) went to farmers' fields to find production problems. The technicians tried to serve farmers patiently and professionally. Three of the technicians said they have been called many times by farmers.

The perceptions of participants on the problems of farmers during the early stage, mid-term and later period were shown in table 24.

Table 24. The Perceptions of Technicians on the Problems of Farmers- Early Stage, Mid-term and Later period

Item	Number	Percentage
All stages	12	35
Early stage and mid-term	7	21
Early stage and later period	4	12
Mid-term and later period	2	6
None	9	3

Technicians were asked at which stages, early, mid-term or late that they think have

more problems. Thirty-five percent of the total technicians thought all stages were important to farmers' farming activities. Some technicians (21%) believed that both pre-production and mid-term were very essential, and they have to solve more problems in these stages. Farmers need to select new varieties in the early stage and are always concerned with pest control in the mid-term to ensure their yields. Some technicians indicated that there were greater problems in the later period, in which farmers need to clear the land, prepare nest farming and be concerned with selling their production. All of these issues need technicians' help. Therefore, for the problems, agricultural technicians need to pay attention to each stage and in a timely way warn farmers. In the survey, there were two participants who believed that there are more problems only in the early stage, and still two technicians had no ideas regarding the question. Table 25 presents some suggestions of technicians who thought that they can improve the program.

Table 25. Suggestions or Comments of Technicians to Improve the Program (multiple answers given by individuals)

Suggestion	Number	Percentage
The internet is slow- needs to be sped up	10	29
None	10	29
Provide more ICTs' training courses	6	18
Improve the 3G platform	5	15
Mobile and laptop post-maintenance	4	12
Invite experts to fields	3	9
Add to marketing information	2	6

Except for 10 technicians, other participants gave various suggestions to improve the program. Eighteen percent technicians wanted to take more courses about ICTs, such as

the training course on fruit trees. A part of the technicians (15%) hoped the AII can improve the 3G platform by advancing the search tool, adding expert dialogue item and so on. Even some technicians thought some information on the platform is too difficult to them. In terms of the support services of the AII and the local STC, 29% of the technicians complained that the Internet is slow; sometimes, they cannot even finish the course reading. Similarly, the post-maintenance of the smart phones and laptops are also important. One technician said his phone didn't work for one month until the staff repaired it. Six percent of the total technicians complained that the local STC didn't pay the cell phones' monthly fare on time and they couldn't use the phones. Further comments from the technicians about this pilot project are presented below.

Table 26. Advice of the Agricultural Technicians to the Program

Item	Number	Percentage
None	19	56
Add functions on the 3G platform	5	15
Set up organizations in villages	4	12
New technology promoted	3	9
Learn other advanced experience outside Miyun County	2	6
Apply subsidies	1	3

For this open ended question, most technicians (56%) gave no response. A few technicians (12%) pointed out that it is necessary to set up an association in a village so that farmers can exchange their experience in the same field. Some technicians also wanted to promote their agricultural technologies further such as the techniques of operation greenhouses. Some people (15%) preferred the 3G platform to provide more

opportunities for them to learn with experts and the technicians and can upload some their own typical pictures. Older technicians preferred getting paper materials on training information rather than electronic versions. A number of technicians hoped that they could have field trips to learn about other farmers' advanced experience instead of doing too much training and writing work.

Local Farmers' Perceptions about the Value of Information and Communication Technologies for Agricultural Extension workers

Thirty-two local farmers participated in the interviews and responded to the questionnaires. The same type of analysis of the data was done with the farmers as above with the agricultural technicians. Their answers were also separated into mutually exclusive categories using open and axial coding and then tables were created to display the results of the themes that their answers were coded. Some questions were given multiple answers by individuals so the percentages usually add up to more than 100%. For example, in Table 29 from a straight forward question with answers that had no need for open and axial coding, there were 32 farmers but 27 said they had cell phones, 13 farmers said they used a typewriter and 5 said that they used a computer. Therefore 27 out of 32 farmers had cell phones (84%), 13 had typewriters (41%) and 5 had computers (16%). This means that some people have both cell phones and computers or even all three and explains why the percentage responses add up to 84% + 41% + 16% or 141% instead of 100%.

Semi-structured Interviews

Thirty-two farmers took part in the research. Table 27 A & B present some of their demographic characteristics.

Table 27 illustrates the demographic characteristics of the local farmers.

Table 27-A. Ages of the Local Farmers

Age	Male	Percentage	Female	Percentage
Under 30-year-old	1	3	1	3
30-40 years old	3	9	2	6
40-50 years old	3	9	7	22
50-60 years old	6	19	5	16
Over 60-year-old	4	13	0	0
Total	17	53	15	47

Table 27-B. Education Level of the Local Farmers

Education level	Male	Female	Total number	Percentage
Primary school	1	2	3	9
Junior high school	8	8	16	50
High school	3	3	6	19
Vocational high school	3		3	9
College	2	1	3	9
None	0	1	1	3
Total	17	15	32	100

It is interesting to see table 27- A is that the numbers of participants, males and females are almost equal. Female farmers are only 6% fewer than males of the total 34 participants. The ages of most farmers are 40-50 years old; females are 13% higher than males who are in the same age group. Another age group is from 40 years old to 50 years old; around 31% people are in this range. There is no female whose age is over 60-year-old. The youngest farmer is only 20 years old. The oldest farmer is 74 years. He still works on the field and manages almost 1.5 acre of fruit trees. In the table 27-B, the numbers of both males and female farmers who finished junior high school occupied 50%

respectively in the total participants. Nine percent of the males graduated from Vocational high school compared to zero of the females. In addition, one female farmer never went to school. Farmers were also asked about their farm's size and how their incomes compared with the previous year and this is shown in Table 28.

Table 28. Farm Size and Perceptions of Income of Farmers in Miyun County (approximate figure only)

	Mu (1mu = 0.16 acre)	**Number**	**Percentage**
Farm size	1-10	21	66
	10-30	7	22
	30-50	2	6
	Over 100	2	6
Income	Higher	26	81
	None	5	16
	Lower	1	3

Because of the large population in China, each farmer only has a small amount of land to farm. The farmers who have less than 10 mu (under 1.6 acre) lands are typical; the percentages were 66 of the total participants in Miyun County. Due to the mountainous terrains, some farmers (4 participants) have some land on hills besides having some land on a flatter surface. Most farmers use the small land to plant vegetables and the hill land to grow fruit trees. Only a few farmers (6%) have over 16 acres land; one of them has 300 mu (48 acres) land to grow walnuts and chestnuts, but the farmer only finished his primary school and said that his production had not changed significantly with the ICTs' help. However, more farmers (81%) indicated that their incomes were improved by the use of ICTs and the help of the agricultural technicians. Many of them have incomes that

increased 30%-50%. Only one farmer said that his income decreased last year due to the flood. Farmers were asked if they use phones or computers themselves and whether they can type. The results are shown in table 29.

Table 29. Usage of Phones, Computers and Typewriters by Farmers (multiple answers given by individuals)

Item	Number	Percentage
Cell phone	27	84
Use Typewriter	13	41
Computer	5	16

Although most farmers often use phones, they usually use only the simple functions of the cell phones by themselves, such as for incoming or outgoing calls. Some farmers can use computers (simple operations on computers). Commonly, farmers can either use computers or typewriters; however, quite a number of farmers can type on cell phones, and not on the computers. Farmers were then asked what they learned from agricultural technicians.

Table 30. Knowledge the Farmers Have Learned from the Technicians

Item		Number	Percentage	Total Percentage
Agricultural technologies	Planting techniques and Pest control Selecting seeds New agricultural management information	 19 6 4	 59 19 13	91
Green fertilizer		2	6	6
None		1	3	3
Total		32	100	100

Most farmers (91%) indicated that they learned various agricultural technologies or

skills from the agricultural technicians, especially in the pest control and planting techniques. Thirteen percent of the farmers were glad to learn modern farm management theories from the technicians. Two farmers changed their farming ways from using chemical fertilizers to green fertilizers. One farmer had no idea because he just helps his father.

Farmers were asked to indicate whether or not they felt that the assistance they received from technicians increased their income and/or production (see Table 31).

Table 31. Farmers' Perceptions on their Income/ Produce with the Assistance of the Technicians

Attitude	**Number**	**Percentage**	**Total Percentage**
Products and income increased	19	59	90
Reduced cost of production	9	28	
Increased farm size	1	3	
None	3	9	9
Total	32	99	99

Most farmers (91%) believed that their income and products were upgraded. One thought that with the help of the technicians his farming scale was bigger than before. Nine farmers of the participants indicated that the technicians instructed them about new skills to grow high quality crops, which helped them reduce their production costs. For example, one of them said that the technician taught him to decrease farming cost or save unnecessary farming expenditures through distinguishing poor quality seeds from high quality seeds. Table 32 presents the expectations of the farmers using ICTs.

Table 32. The Expectations of the Farmers in using ICTs

Item	Number	Percentage
Solve more problems	13	41
Improve production	11	34
Increase farm size	3	9
Change planting structure	2	6
None	2	6
Use organic fertilizer	1	3

Quite a number of farmers (34%) expected that the ICTs can help them improve their production. Forty-one percent of the farmers hoped that they can learn more new agricultural skills in producing, management and marketing so that they can solve more problems by themselves. Some farmers have realized the important role of increasing their farming sizes. They preferred to extend their production scales with the help of ICTs; and someone expected to set up agricultural organizations at the village level and develop more mechanization production. A few farmers (3%) have applied organic fertilizer on all of their fields and some farmers (6%) hoped that the crops they are planting can be changed into economic benefits. Farmers were asked what they thought might be the long term impacts of the program and this is shown in Table 33.

Table 33. Perceptions on the Long term Impacts of the Program (multiple answers given by individuals)

Item	Result	Number	Percentage
Yields	Higher	27	84
Quality of crops	Higher	25	84
	Lower		78
Diversity of crops		24	75
The use of chemical fertilizers, quality seeds or pesticides		25	78
	More pesticides	2	6
Agricultural production	Higher	14	44

income	Lower		
Social issues/ mobility		4	13
	No change	12	38

Though there are multiple plants grown by individual farmers in Miyun County, almost all farmers (84%) still thought that their yields will be promoted further over the long time by the help of the ICTs. They also expected the quality of crops, as well, to be improved through the planting of higher quality seeds and the use of new technologies. With the support of the ICTs, a large percentage of farmers (75%) were willing to grow various or new varieties of crops. Similarly, 78% farmers preferred to use green fertilizers and reduce the use of the chemical pesticides; however, only two of the farmers still added chemical pesticides to their crops to kill more pests. Most farmers couldn't guess what their production or income would be in the future, but 44% farmers of the total participants believed that their production and incomes will be improved over time. On the other hand, the farmers didn't focus on the social issues or mobility in their villages. Only a few people (13%) indicated that with the development of agriculture, more and more villagers would like to stay in their homes. Farmers were asked how they got information before the ICT program was introduced and the responses are in Table 34.

Table 34. Information from the Farmers as to how They Obtained the Agricultural

Information before the ICT Program

Item	Number	Percentage
Learned from other experienced farmers	17	53
Village service centre	6	19
Learn by self	6	19
TV and the internet	4	13
Total	33	104

In this survey, over half the participants (53%) learned agricultural experience/ knowledge from asking older or more experienced farmers. Thirteen percent of them usually watched TV or searched on the internet to get some advanced information before the program was implemented. There were village reading rooms in some villages, but few had the latest information or books in there, and the previous technicians did not instruct the ICTs to farmers like the current agricultural technicians. They just answered some questions rather than going to the fields. Some farmers (19%) learned the information by themselves before the ICT program was implemented. The farmers were also asked to assess the performance of the agricultural technicians and the results are provided in the table 35.

Table 35. The Perceptions of Farmers on the Performance of Agricultural Technicians (multiple answers given by individuals)

Item	Number	Percentage
Responsibility and good service	31	97
Good agricultural technologies	4	13
Ordinary	1	3

Except for one, all the other farmers (97%) believed that the agricultural technicians are highly responsible in their work and provide excellent services to farmers. When

farmers have problems, the agricultural technicians seem to help them in a timely way. In addition, some farmers indicated that technicians who understand good agricultural technologies have other evaluation criteria for their work. Farmers were also asked to provide any suggestion to the agricultural technicians and they are given in Table 36.

Table 36. Suggestions from Farmers to Technicians

Suggestion	Number	Percentage
Learn more skills and help more farmers	23	72
None	4	13
Exchange information with farmers	3	9
Set up village association	1	3
Marketing assistance	1	3

After the program was implemented for almost one year, 72% of the farmers expected that the agricultural technicians should learn more agricultural knowledge and skills so as to provide the skills to farmers. Farmers also needed more information to communicate with technicians to obtain more useful skills from them. Some farmers believed the technicians worked very well and had no further suggestions. However, some farmers still preferred to set up village agricultural associations to access the market and improve their income and the capacities of the whole village.

Farmers were also asked for their ideas on how to improve the program and this is given in Table 37.

Table 37. Ideas to Improve the Program

Item	Number	Percentage
None	16	50
Focus on marketing	6	19
More technicians & information	5	16
Improve technicians' skills	5	16

Half of the farmers had no responses for the question and felt the program was good. Some farmers (19%) suggested the program should focus on market issues, and some of them (16%) still hoped they could obtain more agricultural information or technologies from the program to promote their production. Other farmers wanted the technicians to improve their skills so as to help them further.

Finally the farmers were asked if they had anything else they would like to mention about the program in the form of advice - Table 38.

Table 38. The Advice of the Farmers

Item	Number	Percentage
None	23	72
More instruction to farmers	4	13
Field trip for farmers	3	9
Environmental issues	1	3
Subsidy	1	3

Many farmers (72%) had no responses to the question. A few farmers indicated that they need more ICTs when dealing with their farming activities. Some farmers mentioned that field trips are very important for them to learn and gain experiences through demonstrations on practical issues. It is pleasing to see that some farmers (3%) had concerns about the environmental issues and the subsidies which apply to environmental issues.

SWOT Form

In the research, the agricultural experts and technicians (14 participants) also evaluated the ICT program through a focus group discussion which was used to analyze and identify strengths, weaknesses, opportunities and threats (SWOT) of the program. The results of the SWOT analysis are given below:

Strengths	Weaknesses
1. AII handed out the technological USB to agricultural technicians.	1. There were only 120 USB disks for technicians with laptops, not for smart phone users.
2. Agricultural service sectors are strongly supporting the program. Information exchange on 3G platform is increasing. Simultaneously, the city hot lines: '12396' and '12316', provide experts to answer farmers' problems on line.	2. Network signal was weak because of the mountain terrains in Miyun County. The introduction of varieties through 3G platform; moreover, is superficial. There are a few consulting pictures and the information is not comprehensive.
3. AIRI offered experts' phone numbers to support technicians to ask specialists in certain fields.	3. Getting more information needs technicians to take part in the training, but for old technicians, the information which focuses on short time is too compressed to remember.
4. Learning advanced technologies within Miyun County or the country to develop large-scale production and sustainable agriculture.	4. Sometimes, training will occupy farmers' farming time. Farmers prefer inviting experts to the field or organizing farmers to do field trips.
	5. Farmers did not directly deliver their production to colleges or supermarkets, which required strong organizations to plan the production and deliver high quality produce in a village.

Opportunities	Threats
1. Set up a national information platform, refine information and search by category or concerned project. Through Knowledge Translation and Transfer (KTT) model to transfer new research knowledge to farmers.	1. Because of regional differences and due to resources sharing restrictions, enhancing national experts' team requires a long time of cooperation among all fields and levels.

2. Resources sharing.	2. Need financial support to obtain more experts' help.
3. Experts give answers directly on line and develop consulting options.	3. Because of the practical operation of the field and regional differences, land activities cannot form fixed processes and modes.
4. Find and recruit more local resources into the platform. Not only the Agricultural Service Center, but also the local Forest Protection Station.	4. The market price cannot be predicted.
5. The agricultural technicians are expanding large-scale production and sales work. For example, they intend to encourage family planting, but sell production on a larger scale. There is the trend of e-commerce.	5. Individual farming method guides farmers just to consider personal income or benefits rather than wanting to operate with other farmers and take risks.
6. The roles of agricultural technicians are to help the village to mechanize and encourage sustainable agriculture. When they improve environmental knowledge by themselves, they will help farmers to learn and improve their capacities.	6. It is difficult for large-scale agriculture to be developed in a short time. Since the land is scattered among individual farms, and the quality of the production varies. Secondly, if one considers employment methods, the farmers are not enthusiastic about farming someone else's land unless it gives them more benefits than the farmers would get by farming their own land only.

Summary

There were a total of seventy-one participants in the research: five policy proponents, thirty-four agricultural extension workers and thirty-two local farmers. Sometimes, one person had more than one answer or expectation for some questions, so some questions would get multiple answers which have been shown in the tables. I categorized every question and identified the theme according to the tables. For example, table 12 presented

the perceptions of the technicians on farming techniques which they believed is expected by the AII and STC. All 34 responders gave six different types of answers, but the “use of 3G platform/ICTs” was the highest expected skill (100%) by the technicians and the government. Adding up skills’ percentages, the total percentage was over 100%.

The agricultural technicians are farmers too but they are professional and educated farmers. Through the research, I knew the AII is a policy implementation institute. Since the program was implemented in Miyun County, the local Science and Technology Committee provided strong support to the project. Though the AII offered the 3G platform and laptops or smart phones to the agricultural technicians, the STC was responsible for the technicians’ training courses, tools post-service and their management.

The numbers of male and female participants in the research were almost equal. Most agricultural technicians had graduated from high school while most farmers finished junior high school. In the County, like most rural areas of China, the ages of farmers are between 40-50 years old. Through the survey, the agricultural technicians and farmers presented their perceptions about the program and expectations of further learning or applying ICTs on the farm. Most farmers believed that the program was useful for their farm activities and hoped the technicians can learn more new technologies so as to promote farmer production or market sharing. The data analysis showed that the ICT program in Miyun County provided efficient agricultural information. The agricultural technicians played key roles to translate or transfer the modern agricultural knowledge to farmers. With the assistance of the ICTs and the 3G platform, sustainable and large-scale

agriculture will probably be relatively quick in Miyun County.

Chapter Six: Discussion of the Research Findings

Introduction

Since the purpose of the research was to discover the important role of Information and Communication Technologies (ICTs) about the farming activities of Miyun County, I interviewed three groups including policy proponents, agricultural technicians and local farmers who employed farming activities with ICTs and the technicians' assistance. The 3G platform for ICTs has been promoted and applied for almost one year (since September, 2011) by the Agriculture Information Institute (AII) in Miyun County. The AII is committed to developing ICT innovations and public services for rural farmers. As a research institute, AII performs its duty to develop agricultural information technology according to national plans, rather than being a decision-making institute.

Agricultural technicians are farmers too and they have land and also farm. In addition, the Miyun Science and Technology Committee (STC) provides comprehensive training courses from information technologies to pest control in all aspects of agriculture, forestry, animal husbandry and fishery. Such agricultural technicians are professional farmers because they not only farm themselves but help others farm more effectively and for the latter, they are paid a stipend. They assist ordinary farmers with ICTs and learning about the 3G platform. Such ordinary farmers are usually less educated than the AII and the STC who refer to them as the peasantry. The agricultural technicians are the key bridge between the new information, technologies and farmers.

There were 34 agricultural technicians and 32 local farmers in my survey. Female technicians (19 persons) and farmers (15 people) were respectively occupying a half of

the total participants. Through the research, we found that the young agricultural technicians (around 30 years old) are quicker to learn and grasp new technological information than older technicians (after 45-year-old). Furthermore, older farmers preferred to adopt conventional farming methods that they were used to instead of taking risks to use new farming methods. In addition, younger technicians had a strong awareness of the environment and instilled it in farmers, but there were no distinctions between males and females, and even with educational levels among technicians and farmers. This survey also illustrated the relationships among the program institutes, agricultural extension technicians and farmers and their expectations and perceptions about the project. Simultaneously, the research reflected the attitudes of most people to the use of ICTs in Chinese rural areas.

Framework discussion

In the conceptual framework part of the literature review, I stated that to improve sustainable agriculture in China's rural areas requires the cooperation between the institutes, the agricultural technicians and farmers using the new technologies with the natural resources as Chinese agricultural development occurs. In other words, every level such as the government, research institutes, farmers and natural or capital resources needs to collaborate and be involved in the program. The AII implemented the 3G platform to provide ICTs for farmers in Miyun County and supported laptops and smart phones for every agricultural technician. Following the AII, the Science and Technology Committee (STC) created an enabling context in Miyun County for improving the use of the ICTs. In

addition, with the practice of the agricultural technicians and farmers, farmers' capacities have been promoted. They are exploring the ways to save farming costs and manage their farming activities in a business way. They have the awareness of sustainable agriculture and are willing to adopt large-scale farming methods or set up village cooperatives to increase agricultural productivity.

Land policy

Because China has been focusing more on the field of the industry since the 1950s, Chinese agricultural productivity is somewhat behind compared with other industries. In the agricultural field, the government usually makes more top-down policies for agricultural development. After 2000, the government has realized the important role of agriculture in China so as to develop a 'New Rural Campaign' (Jia & Fock, 2007). That is designed to eliminate the inequality between urban and rural areas through improving capacity building and institution building (village organization level) of farmers. The program of Miyun County belongs to the 'New Rural Campaign', which is focusing on capacity-building for farmers with the use of ICTs. After the practice of the program in Miyun County, my survey was implemented to uncover if the project is effective for farmers and for most Chinese rural contexts.

Jia and Fock (2007) also argue that the government should concentrate on capacity-building and institution building for farmers who need to pay more attention to various markets and their participation rather than using a top-down mode. However, the bottom-up development mode needs to be based on a well-developed structure for

transmitting information and norms among economic agents (Jia & Fock, 2007). China, in the present, still relies on more top-town policies to improve and regulate markets and product methods because of the special land policy and the Hukou household registration institution. The AII is expected to improve the public service capacity of agricultural extension agents as well as the capacities of farmers through the development of the use of the 3G platform and ICTs, and then the government will attempt to use more bottom-up methods such as the development of Knowledge Transition and Transfer (KTT) approach to make more policies and decisions.

The same as other rural areas, such as in Miyun County, farmers only have 30 year rights to use land via a lease and only households who have rural Hukou have the land. This lease, usually is rolled over, however, so the farmers can continue leasing the land. In fact, almost every villager has land in the village; if farmers or other people want to have more land, they can buy the land from the local government of the village. Actually, anyone can have the use rights for the land if the village government provides the land. On the other hand, due to China's large of population (1.3 billion) (The six national census of China in 2010), many farmers only have several mu of land, or less than 1 acre (1 mu= 0.16 acre) per person. That makes more and more young farmers to get rid of their rural identification and land to be migrant workers to obtain higher incomes. That is the main reason that most farmers who do farming activities are around 40-50 years old in Miyun County and even throughout China. Such farmers usually adopt conventional farming methods and it is difficult for them to learn new technologies and change their

farming habits. Fortunately, although many old farmers find it too hard to remember modern information or techniques, such farmers have richer farming experience. With the long time assistance of the agricultural technicians, they have positively used more and more new varieties both of vegetables, crops and fruit trees. Actually, for the limited amount of land given to the farmers, the farmers prefer to apply modern technologies to improve their products and incomes.

Since the increasing numbers of young or skilled farmers are going to work in the cities, Sun & Fan (2011) indicate that the elites' requirements for migrants put the migrant workers at a disadvantage in Chinese social and economic development. It is true that most city positions require a high educational level and/or extensive experience. However, in order to obtain a higher income and better living conditions, more and more young farmers still go into the cities although there were agricultural technicians to help them promote their incomes with ICTs in their villages. Compared with the high speed development in big cities, the method of using ICTs needs a long time to develop in rural China. What's more, with the improvement of agricultural modernization, more and more laborers are being relieved from heavy farming work. They have more opportunities to be migrant workers in the city. The data showed that several technicians were concerned about social mobility; some of them thought that the villagers' mobility is steady, but more of the respondents (either technicians or 38% of farmers) thought there was no change in social mobility as even more villagers go to other cities to work.

The 2003 Rural Land Contracting Law (RLCL) provides a secure legal basis for farm household property rights so that farmers receive written 30 years land use contracts for arable land, 30 to 50 years for grassland, and 30 to 70 years for forestland (Deininger, Jin, Xian &Rozell, 2004). In addition, the Chinese national government encouraged provinces and counties to implement "land rights experiments" in a total of 18 national experiment zones for rural reform (Deininger et al., 2004). These experiments emphasize making land available for large-scale exploitation and giving households more secure land rights. To some extent, although the land policy in China restricts farmers' extension, farmers still can use their land for a long time. Generally, the farmers can keep or farm their land for life if the government doesn't collect the land for another use. Moreover, the government encourages people to make a contract for a larger amount of land to develop large-scale and modern farming. Therefore, with the development of the Chinese agriculture and economy, land policy will be promoted and changed slowly. The use of the ICTs in rural villages is the Chinese government's way of combining this approach with decentralized implementation at the local/ user level so that stakeholders can directly be empowered by the policy.

The context of the use of ICTs

As Deng (2012) and Liu (2009) indicated Chinese farmers need to adopt ICTs to improve farming productivity and farming structures intensifying land use efficiency and minimizing destruction to the region's eco-environment. In order to feed 1.3 billion people in China, developing agriculture and ICTs during the early stage requires

top-down strategies (the China-DAC Study Group, 2010). The program was implemented in four different provinces' rural regions (Beijing, Jiangsu, Henan and Xinjiang). Miyun County is the second successful pilot with the strong support of the local government. For developing the ICT program, the most successful pilot is Jiangsu because there are rather mature modern farming modes or village organizations for many years compared with the other three pilots. However, the 3G platform and ICTs are not as primary a method in Jiangsu as in Miyun County.

Due to the mountainous terrain and water scarcity in Miyun County, many farmers grow fruit trees such as walnut trees or grapes, which use less water than most crops. The traditional over flow irrigation system (Henry, 2004) is still used by Miyun County's farmers. Almost all farmers depend on rainfall and ground flow for irrigation besides several farmers who manually irrigate their greenhouse vegetables. Ninety-seven percent of the irrigation in China is done through overflow or open water channels (Henry, 2004). The effective utilization coefficient of agricultural irrigation is only 0.45 which is far below the levels of 0.7 or 0.8 in developed counties. In most areas of Miyun County, farmers still adopt this irrigation method for their land. Not only the mountainous terrains but also the irrigation methods, lead to water shortage in Miyun County, as well as on most of the rural areas of China. For this reason, drip irrigation, which makes more efficient use of water, should be employed (Stoskopf et al., 2004).

Henry (2004) says that a county or town water bureau with farming communities should share responsibility for rural infrastructure rather than always rely on top-down

policies. In fact, with the development of this program, the AII and the local government will pay more attention to rural infrastructure such as the irrigation method and the cooperation of all levels in both rural and urban areas.

With the assistance of the agricultural technicians, more and more farmers have attempted to grow new varieties to extend their planting areas. An increasing number of farmers applied green fertilizers and a few pesticides on their yields rather than organic fertilizers that are too expensive to use for many farmers. Respondents believe that ICTs have improved farmers' produce and incomes but not irrigation. The infrastructure development still needs the national and local governments to work more closely together. Farmers do not have the ability to improve the system on their own. Therefore, the program which uses ICTs and the 3G platform to improve farmers' capacities is only acting on individuals not on the infrastructure's improvement. However, with the development of the capacities of farmers, for the purpose of reducing farm costs, farmers and even the local government will make more demands on the development of infrastructure.

Individual farming

Until now, the individual/ family farming method is still the primary farming way in rural China as well as in Miyun County. As the China-DAC Study Group pointed out in 2010, the small farmers are more flexible and dynamic for China's dramatic economic transformation and structural changes. However, the style might lead to farmers just considering their personal income or benefits rather than cooperating with other farmers

to take risks in large scale farming. Since the land is scattered into individual farming, the quality of the production is different. Secondly, concerning employment, the farmers are not enthusiastic about farming someone else's land. Although some technicians and farmers have extended their farm sizes, set up village organizations, and more and more farmers also see the benefits from the large-scale, they usually are willing to depend on the top-down policy of the government instead of themselves. The ICTs project is designed to promote farmers' capacities at the grassroots level so that the farmers can rely on themselves but not the government over time.

Regarding the small farmers, the AII is implementing the one-to-one agricultural extension method which had been experienced in Ontario, Canada prior to the reduction of the number of extension agents. The one-to-one extension method allows individual farmers to get free government agricultural information and the help of public agricultural extension. However, with the development of the private agricultural business and the desire of saving government money in Ontario, especially during the Mike Harris Conservative Government period of the latter half of the 1990s, the agricultural extension offices were reduced to 8 from 50 in 1995. The one-to-one method has become one-to-many form that was less adapted to the target category, such as small dairy farmers or large crop producers (Ceplis, OMAFRA Elora Office, Aug. 8, 2012). Chinese agricultural extension therefore has the potential opportunity to combine its one-to-one form of extension with the one-to-many access that will come once better access to ICTs are provided through their 3G platform. Meanwhile, OMAFRA is now

depending very heavily on its one-to-many form of Knowledge Translation and Transfer (KTT) which some feel will not reach the hardest to reach small scale farmers who are not in a position to be able to purchase privately available extension from entrepreneurial agricultural specialists who provide it to those who can afford to pay. Thus this form of private extension is mainly available to the larger scale farmers whereas in China publicly funded agricultural extension is still available to both small scale "peasants" and larger scale "professional" farmers.

In China, no such entrepreneurial agri-businesses or organizations exist so the AII wants to find a way to provide simple, plain speaking research results to farmers like the ICTs and the KTT. In Ontario some farmers, especially of a small scale have insufficiently implemented environmental best management practices (Filson et al., 2011) in part because they lacked information and the capital needed to keep them environmentally friendly and competitive with larger, capitalist farmers. It is unlikely that the KTT one-to-many form of agricultural extension, Chinese farmers are now getting will enable them to improve sufficiently to be able to cope in the difficult, competitive market place within which they must function if they lost their one-to-one form of agricultural extension as has happened to Ontario's farmers.

The application of ICTs in Miyun County is during the early stage of one-to-many method that will be designed to move the small holder farms towards large, private farming over time. Small farmers will rapidly disappear in Miyun County with the fast pace of change of agricultural development. For environmental protection and the

development of sustainable agriculture, Chinese farmers have to participate in the competition with larger, more efficient farms and unfortunately this requires experiencing some farm reform pains.

The gender situations of technicians and farmers

Through my survey, it is interesting to see that the numbers of participants of males and females are almost equal. Female farmers are only 6% fewer than males of the total 34 participants. From the policy proponents' level, males occupied the main positions at the decision-maker level and the only female is from Miyun Science and Technology Committee (STC) not the Agriculture Information Institute (AII). Through the data, there are no big differences between males and females who accessed the ICTs. The women (56% females of the technicians) are playing key roles helping farmers in Miyun County. Also, the female farmers (see table 16), learned and used ICTs just like males. Although it is commonly believed in China that men should farm the land, in fact, more women now undertake the same work as men in rural China. Most females usually work in the agricultural fields; instead, most of the men go to cities to earn extra money so in this sense my sample was disproportionately comprised of men. Although during my interviews many female farmers showed their enthusiasm about learning new ICTs, the main reason was such women just took over all of the farming work after the men went to cities to be migrant workers. The women need to replenish their agricultural knowledge to work for their families. With the help of the ICTs, female farmers would obtain more new farming skills so that they no longer have to be confined to heavy labor.

The age of technicians and farmers

For the AII and STC personnel, their ages are around 40-50 years old, which means they have more experiences around their work than younger farmers. In addition, technicians around the ages of 40-50 years old with experience and good learning abilities are common (15 people) in this program. Most females are between 30-50 years old; around 31% of the people are in this range. Of those female farmers who are 40-50 years old, this is 13% higher than the males who are in the same age group (table 27-A). There are no women whose age is over 60-year-old (table 27-A). The youngest male farmer is only 20 years old in the survey and the oldest farmer is 74 years old. He still works on the field and manages almost 1.5 acre of fruit trees. In the ICTs program, on the one hand, because the older farmers find it is not as easy to use/ accept new farming techniques, they need the agricultural technicians to help and instruct them in an easy way. Furthermore, such farmers prefer to adopt conventional farming methods and it is often harder for them to set up or join in communities/ organizations. It can be difficult for old agricultural technicians and farmers to learn and grasp new ICTs quickly, specifically, many participants still are used to using paper materials instead of electronic versions. Nevertheless, all technician participants and 90% of the farmers are accepting ICTs (table 30/ 31) through the program.

The educational levels of technicians and farmers

The overall education of farmers in China is low compared with that of most urban Chinese residents. In total of all 480 million farmers, the farmers who have college

diplomas is lower than 1 percent. High school education accounted for 13%; and the farmers who finished junior high school education were only 49% (Wang, 2006). Compared with the average education statistics for farmers, however, most of the research participants in Miyun County were better educated. Both the number of the agricultural technicians and farmers who have college degrees were higher, reaching to 9%. Technicians who finished high school were 65% of their total; otherwise, half of the farmer participants finished junior high school. Although the numbers of both males and farmers who finished junior high school respectively occupied 50% of the total participants, educated female farmers were still fewer than males and there was even one woman who never went to school (table 27-B).

Generally, researchers thought that farmers who have lower education would find it difficult to adopt ICTs or accept new farming ideas. Yet, of all the technician participants, only one man graduated from junior high school but he has been the leader of his village's cooperative for seven years. He organized a vegetable association which combines his village and neighboring villages to develop larger scale production and uniform sales.

The uses of ICTs

Although the AII launched the 3G platform and allotted laptops and smart phones for agricultural technicians, the Miyun STC is still the basic support for the program. The STC provides training courses to technicians and maintain services about ICT tools. The STC solves most basic problems of technicians' and farmers' at the local level, such as

repairing ICT tools and contacting agricultural experts and so on. Because more and more agricultural problems are being dealt with due to the development of the use of ICTs, the STC and agricultural technicians need more support from the AII and the government. The AII is considering combining the city hot lines: '12396' and '12316', which were set up by the Ministry of Agriculture. The two hot lines have numerous agricultural experts and have run for many years, so if they can share the specialists on the 3G platform to answer farmers' problems on line within the project, farmers can obtain more information with ICTs and the program will be quickly promoted further as well. Similarly, if the KTT program is beginning, more social resources and agricultural knowledge will be transferred and serve rural farmers.

Regarding the 3G platform, the AII required agricultural technicians to upload reports every day so that they can understand technicians' work and farmers' problems at all times. Usually, farmers are faced with a problem which another village has solved; the technician will see the information and experience to settle the same problem in his/her village by reading the information on the 3G platform. Through such communication, technicians and farmers solved many problems within the platform. Another convenient way for farmers and technicians is that when famers meet a field problem such as a rare disease which the agricultural technicians also have never seen, technicians will connect experts through their laptops or smart phones to show realistic field situations to experts on the field so that they can solve the problems on line. Those methods are not only more suitable for their local planting environment but also save lots of expert fees and time

because the STC would not have to pay fees to experts who would have to visit the village and solve problems.

It is well known that farmers can get rich by using science and technology; however, to diffuse ICTs in rural areas, the communication infrastructure and services are very poor in many developing countries as well as in China. Miyun County is no exception. Before farmers got help from the technicians, they just sought new farming methods by themselves or asked old farmers who have more experience in the same village. Their information and communication with experts beyond the county were blocked. Because the agricultural technicians would use the Internet to get information from the 3G platform, broadband services would be developed very soon in Miyun County. However, through the research, we still found from many agricultural technicians that the network signal is weak because of the mountainous terrain in Miyun County. One reason is the government cannot invest more money to serve very remote areas. Another reason is the mountainous terrains of which it is hard to open broadband or build communication facilities. In fact, few farmers use computers or other modern technological tools in farming activities. The AII knows about this problem; they will contact the network operator to solve the issue in the near future. Moreover, such problems require the government to create an enabling environment through ICTs investment over a long time. That enables farmers who live close to the cities to conveniently access computers or the Internet more easily than people who live in remote rural areas. That's the reason why

many farmers (reported above in the Findings) used computers in some villages but some villages cannot.

The capacities of technicians and farmers of Miyun County are indeed improved since they employed ICTs in the farming activities. Most agricultural technical participants (71%) thought that their farming knowledge was improved. Some technicians, around 24% and 26% respectively (table 15), believed their communication skills and the abilities of the use of ICTs for farming are being improved quickly.

In Miyun County, most agricultural technicians (56%-table 21) pointed out that the most efficient experience with ICTs was pest control. Most farmers (91%) also indicated that they learned various agricultural technologies or skills from the agricultural technicians, especially in the pest control and planting techniques (table 30). For pest control, farmers usually apply non-pollution fertilizers rather than organic fertilizers. Farmers usually ask technicians how to mix green pesticides and when it's the best time to use non-polluting pesticides and so forth. The cost of non-pollution fertilizer is lower than organic fertilizer and it also can help maintain food security. Because of the diversity of plantings, a few vegetable farmers preferred to use organic fertilizers. One farmer said his organic vegetables are in short supply on the market. Another method of pest control is adopting new pest-resistant varieties. With the support of the ICTs, a large proportion of farmers (75%-table 33) were convinced to grow new varieties of crops. The agricultural technicians usually grew new varieties first and then instructed them about planting methods. With the help of the technicians, more and more farmers tried to

extend their diversity of crops, such as with various fruit trees or vegetables. More farmers (81%) acknowledged that their incomes were improved by the use of ICTs and the help of the agricultural technicians. Many of them have incomes that increased 30%-50% (table 28). The program integrated agriculturally experienced technicians and new ICTs to help local farmers in rural villages and enabled farmers to learn agricultural knowledge efficiently and then get rid of the old ways by asking other old or experienced farmers or learning the information by themselves. What's more, it gave farmers a hope to improve their incomes and to access global agricultural markets.

Because of the Chinese land policy, which to a large extent, restricted large-scale farming in rural China, the small scale farmers have no extra funds to change their farming methods in a more mechanized way. Furthermore, with the urbanization, transport roads, residential and even individual cemeteries occupying more arable land, this continually decreases the amount of farm land. For a big population but small arable land, using ICTs and developing large-scale farming provides hope for China's agriculture to be more sustainable. Although the small individual /family farming method enables Chinese farmers to have more flexibility than a big organization, the small farming methods have hindered Chinese agriculture from developing into large-scale and more productive farming. The ICTs have penetrated into all aspects of farming's production: pre-production, midterm and later period. And farmers believed that the ICTs could help them deal with production issues and break the limitation of too little land.

In response to the survey, the agricultural technicians indicated that the introduction of varieties on the 3G platform, moreover, is superficial. For instance, the section of 'agricultural advisory' on the platform is too general. It has no geographical features and no management or planting information. Some farmers expected that they can upload some agricultural photos to further explain their experience instead of only as recipients. The situations showed that with the support of the ICTs, farmers' capacities have improved; they have started to rely on new technologies and required further agricultural knowledge.

Training for agricultural extension workers

Getting more information requires technicians to take part in training programs. The Miyun Science and Technology Committee (STC) provides comprehensive training courses at fixed times (usually twice a year) from information technologies to pest control in all aspects of agriculture, forestry, animal husbandry and fishery and etc. However, such training courses are general and cannot meet farmers' practical issues. Furthermore, for old technicians, the information which was focusing on a short time is too compressed to be remembered during a short training. Agricultural technicians and farmers can improve their capacities over time but that is slow and inevitably wastes some human or material resources. In the research, in the 34 villages, some technicians (9%-table 25) prefer field trips to fixed training events. The same proportion of farmers (table 38) also mentioned that the field trip is very important for them to learn advanced

experiences by showing them the practical issues which agricultural technicians cannot solve.

As an important bridge of the program, the agricultural technicians impact the development of the ICT program. Agricultural technicians learn the new knowledge and then translate it to farmers. They would be the pioneers using new farming technologies or methods. However, following the improvement of the program, both the AII and the farmers expected the extension workers can learn or transfer more knowledge. In particular, the AII is developing the KTT that requires further advanced agricultural skills and scientific knowledge for the technicians. Consequently, the further development of the agricultural technicians is an issue that the AII needs to consider. In the future, with the development of the KTT, will the technicians become the leaders of large-scale agriculture or will only the richer farmers in their villages be the teachers? With the support of the AII, will the agricultural technicians obtain the first-hand information that will give them a competitive monopoly in the village? Such issues need to be further explored by researchers.

The influence of ICTs

In accordance with the small-scale farming type of Chinese farmers, the market outlets have become increasingly important with the advanced agricultural technologies regarding every householder. With the assistance of agricultural technicians and ICTs, the farming production costs and management expenses are being reduced. Consequently, farming scales and production could grow dramatically. Nin-Pratt et al. (2009) state that

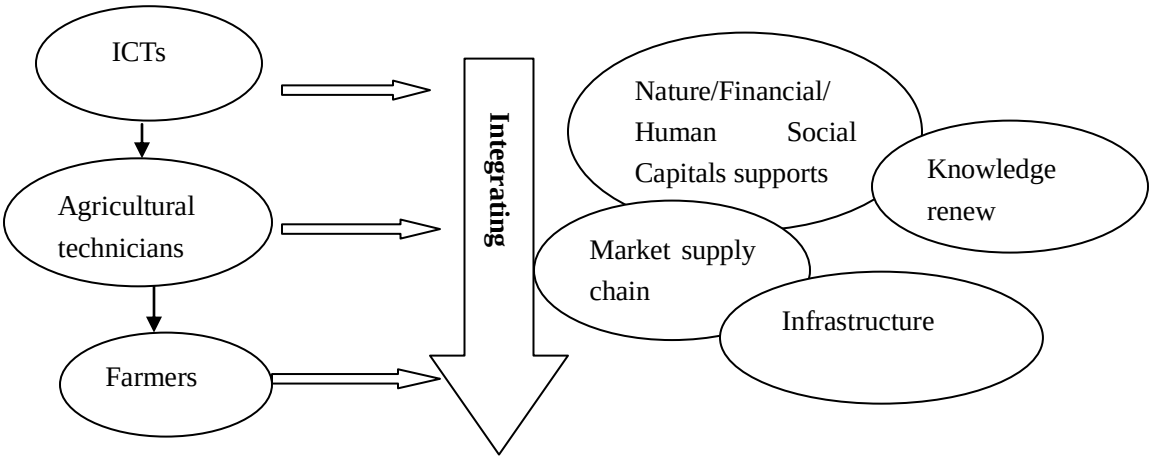
China's modernization of agriculture strategies were largely market driven with regard to both production and productivity. China's technological changes drove Chinese agriculture reaching the frontier of total farm productivity (TFP). In fact, there was a rapid growth of China's productivity (4.4%) during the 1990s while in India, the TFP expansion was only 0.3% (Nin-Pratt et al., 2009). However, if the market chains don't integrate very well, there will be a big problem for farmers' produce--overstorage. With the improved production, the Chinese farmers are encountering this storage problem. For example, Chinese cabbages and radishes were unsalable in Hebei province in 2011, and in 2012; apple-pears were also overstocked in the northeast of China. In Miyun County, only a few large producers can supply their bulk production to the local supermarket; most farmers' yields still rely on individual or small company acquirers to collect the produce in the village (table 22-A). As a result, with the promotion of agricultural production and technology, improvement in market and infrastructure such as irrigation are required in rural areas as well.

Zhong (2004) claims that rural market information services network can connect cities, provinces and counties thereby establishing wholesale markets, large households of production and business operations. The program is not only focusing on the use of ICTs but the raising of farmers' capacities. The AII encourages agricultural technicians to introduce new varieties of crops, conduct experiments and engage in marketing and post-harvest services. The institute expects that farmers can use all of the ICT resources such as broadcasting, video, documentaries, hotline and modern technologies to obtain

supports from local institutions to agricultural businesses. Given the unpredictable nature of the market, farmers need more marketing information on the 3G platform and more support for their use of the ICTs. Farmers also need more forms to communicate with technicians to obtain more useful skills from them. For example, in table 36, seventy two percent of the farmers expected that the agricultural technicians can grasp more agricultural knowledge and skills so as to transfer the skills to them.

The agricultural technicians in China are the new roles for Chinese agricultural development. The framework below shows the bridge between new information / technology and farmers. Agricultural technicians contribute a key role of translation of advanced skills to farmers. However, it is still in the experimental stage of China, with the development of the program some inadequacies were shown in the survey.

Figure 1: The ICT Mode of Miyun County



First of all, formerly the support for agricultural extension workers were only staying at the county or village level; there were no other integrative resources supporting either

the provincial or national level such as natural resources, capital resources or human resources around Miyun County. Secondly, the agricultural technicians are fairly old (around 40-50 years old) and with the less educated technicians they need a continual knowledge supply to meet the new, developing technology. Next, the program in Miyun County was not a market incentives system; as a result, there is a serious gap between the agricultural production and the market. Although the ICTs were partly designed to improve farmers' knowledge of the market by letting them know about it whether in China or abroad, at the moment, they can get a good price for their produce, the development of ICTs in Miyun County only focused on improving farmers' incomes or their farming methods instead of the market demand or pricing. Most agricultural technicians have little if any awareness of the overall or long-term benefits of these new technologies on agriculture. In spite of the possibility of agricultural technicians providing better knowledge of the market to farmers by the use of the ICTs so that the farmers could know the best price on the market for their product, (most of the farmers depend on wholesalers to buy their produce) and the agricultural technicians also have little marketing experience. The purchase price is different from the selling price but the technicians cannot help the farmers. Consequently, though the production may be improved by the new technology, farmers are often faced with the dilemma of increasing production and decreasing market linkages, unless the ICTs are used expressly to identify the specific markets for this greater food productivity. Finally, the local infrastructure often cannot meet the needs of agricultural productivity. Furthermore, farmers are not

able to impawn their land to obtain extra money to purchase big machinery because they lease it, they don't own it. Based on information about the ICT program which is being implemented in Miyun County, there are many problems with Chinese agricultural development. Developing ICTs in China therefore requires the help of a system such as the OMAFRA-U of G Knowledge Translation and Transfer system to integrate both Chinese agricultural producing and marketing systems.

Comparing Miyun County and China's ICTs experience with other counties' experience

The ICT program development in Xinghua city, Jiangsu, is more modernized and mature. It was begun in 2009. The AII only provided fifty 3G netbooks to the agricultural technicians. The local farmers have their own mechanized organization and use the GPS system for farming the land. The ICT program played a pioneer role for the development of the ICTs in Xinghua City (Agricultural Extension Network, 2011). In Luohe city, Henan, the local government and farmers started the ICT program in 2010, but they are usually focusing on the development of the cooperatives instead of on the individual's ICTs awareness. According to Liu (2012), the agricultural experts go to villages to instruct farmers in the fields instead of diagnosis through ICTs. As well as in Xinjiang, the 3G agricultural monitoring platform was started earlier this year (Yang, 2012). The local government pays more attention to set up the Agricultural Technology Promotion Station (Xingjiang Agricultural Information Network, 2012) in 360 villages and towns rather than the one-to-one ICTs approach. Comparing Miyun County's pilot project with

the three ICTs pilots, the development of the ICT program in Miyun County was professional and successful.

It is well known that ICT-based agriculture can improve farmers' capacities and improve their livelihoods. The program of ICTs for sustainable agriculture and food security has been implemented by InfoDev in Africa in 2009. In Africa, the InfoDev launched Capacity-building workshops for local community officials, farmers and agricultural extension workers. The workshops encouraged all of the agricultural staff to participate. However, in China, farmers are not willing to take part in a workshop unless the less experienced/educated farmers, professional farmers who are developing agriculture by themselves are sitting in a class. However, the Miyun ICT program provides resources in both human and technology and it has a monitoring system to promote the work in all aspects with other institutes in the society. For example, not only the agricultural technicians and the experts from AII and Miyun STC, the local Agricultural Service Center, Forest Protection Station and even the hot lines in Beijing like '12316' were also gradually integrated into the program to assist farmers using ICTs and improving their productivity.

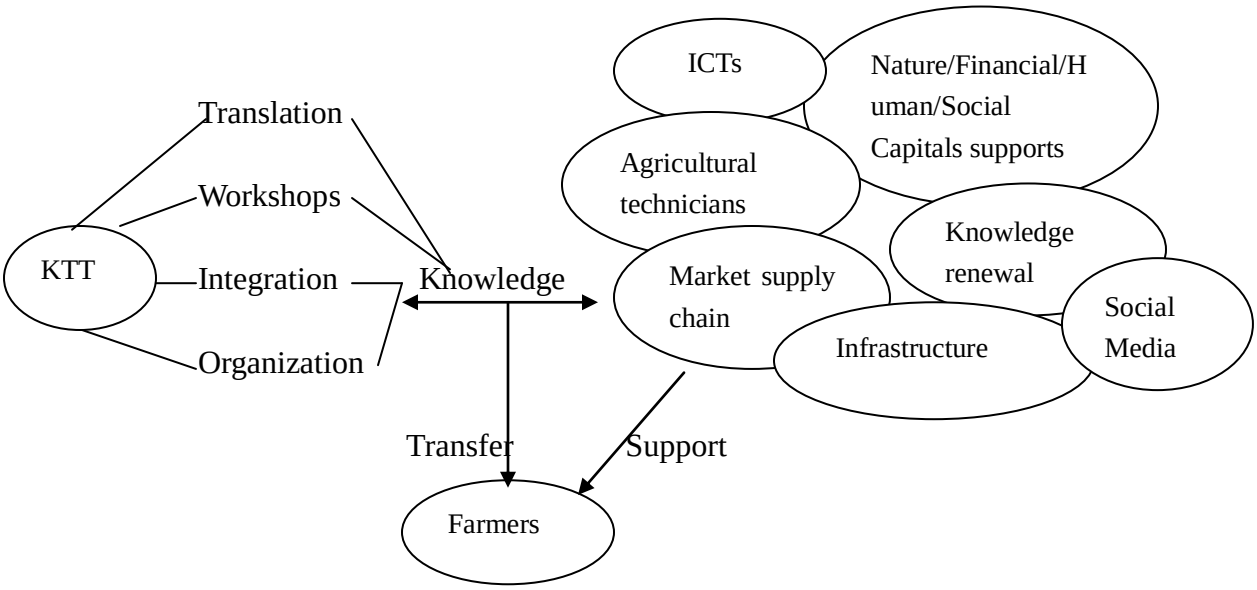
Although the experience of using ICTs in Africa is not completely suitable for China, the four groups' idea in Africa (Deloitte, 2012) is useful for small scale farmers in China. The four groups are business, farmers, researchers and governments which cooperated to help individual households. Compared with the methods of Africa, the Chinese method paid more attention to the government policy not to the other three groups. That means

the government makes policies or rules, and other people or groups carry it out. Such top-down methods were decided by China's national policy stand on agriculture since the 1950s. To explore the development of ICTs in China, we were not only learning from developing countries but also learning from developed countries like Canada. As Wolfe and Bramwell assert (2012) the adoption of ICTs in Canada was encouraging behavioural changes (not only of farmers) but also other individuals and organizations. Canada has developed ICTs both in industry and agriculture to change market conditions. It focuses on Knowledge Translation and Transfer (KTT), digital skills training and Information Technology professionals (Wolfe & Bramwell, 2012). In a manner similar to what Canada has been doing with ICTs, China is bound to concentrate on developing ICTs and KTT for less educated farmers. The AII is working to develop KTT in China for sustainable agriculture, large-scale farming and efficient agricultural organizations.

As with the KTT's development in Ontario, Canada, the effective KTT can integrate various capitals and resources, such as natural resources, stakeholders and decision-makers, to enable them to be indigenized so that all level of resources are able to focus more on local agricultural production and market. Then, as the KTT emphasizes, discover farmers' problems through workshops and field days (OMAFRA, 2010), and combine relevant stakeholders to facilitate the translation and application of new knowledge and technology. Third, the KTT model could help local farmers pay more attention to the local and even the national markets so as to set up provincial agricultural guilds like the Ontario Federation of Agriculture organization which lobbies government

on behalf of farmers. The KTT is also a catalyst, just like the ICTs, and its main purpose is to combine the industries, businesses, research fields and agriculture to transfer the abstract scientific knowledge into practiced skills and gradually pass them on to farmers.

Figure 2: The General KTT Mode:



Compared with the ICT framework of China, the KTT mode obviously combines various sources and supports. In view of the need for Chinese ecological agricultural development, China's agriculture requires that farming methods be updated, seed breeding be improved, production, pest control and food security and nutrition be enhanced, by developing improved agricultural basic/key research and development and being concerned with comprehensive agricultural base building. The ICT program of Miyun County is in the beginning stage to develop the KTT model in China. That program improved farmers' production and incomes further and involved preliminary seed breeding skills, pest control and food secure issues, particularly through this

program. Agricultural technicians not only stayed with the use of ICTs but also were required to continue to promote their own capacities of organization and the market. However, the agricultural technicians only influence their villages or a few farmers who are willing to access ICTs. For example, the agricultural technicians employed village broadcasts to inform farmers about the new farming information in their villages. The technicians were not yet using modern social media such as Twitter and YouTube, etc. However, a survey shows that 84% of farmers and other agriculturalists in Ontario used such social media (OMAFRA and U-of-G, 2012). That was an on-line survey; however, it is no doubt exaggerated as it didn't include those who do not use computers. Agricultural users of social media in Ontario are likely far fewer than indicated by that survey. The agricultural innovations such as setting up food security and nutrition standards, developing agricultural basic/key research needs an experienced model to be involved in all social aspects at the early stage. The KTT approach to Ontario agricultural extension pioneered by OMAFRA may therefore be a suitable approach to help China manage and protect the Chinese agricultural environment and to improve farming profitability.

Summary

Through the research, information from the policy proponents, agricultural technicians and farmers about what they believe regarding developing ICTs a primary method to improve rural economics and develop sustainable agriculture in China was obtained. As DCD and DAC (2004) claim that economic growth is more likely to be produced in societies that are healthier and better-educated. With the development of the use of ICTs,

more and more stakeholders would pay attention to their livelihood conditions and environmental knowledge.

Although the land resources are still under the national government's control, the government has generally returned more and more land benefits to farmers, such as improving the compensation rate for occupied land. With the importance of the government's support for agriculture and farmers' livelihoods, farmers will regard the land as the roots and source of their survival so as to protect and develop it. Similarly, the small-scale/individual farming method is now out of date and is not adapting to the demands of the market and the rapid economic development both in China and internationally. In time to come a sustainable large-scale farming approach will become the primary purpose of the Chinese agricultural development.

Compared with the other three pilot areas, the advantage of Miyun County for developing ICTs is because it is near Beijing. The Beijing AII could conveniently help and monitor in developing ICT procedures, and the positive cooperation of the Miyun Science and Technology Committee also helps. With the development of the program, both the agricultural technicians and farmers will request more ICTs' and other resource supports. Especially for female farmers, the ICT program would remove physical factors and involve more women in farming activities. The program has contributed to the promotion of agricultural productivity and will involve more stakeholders from the government, research and business. As the advancement of the program, researchers and businesses will be more important in improving agriculture and capacity-building.

The most important part is that the program illustrated that the new relationships among local government, agricultural technicians and farmers can work together. Since the program is still in the early stage, some drawbacks will have to be improved with the support from all agricultural levels. In conclusion, the ICT program of Miyun County presented an advanced farming model in rural China. Chinese agricultural extension is getting better with the support of the government even though its agriculture is too fragmented, too dependent on small farms and some old technologies. The AII through the use of ICTs in Miyun County, expected the one-to-one farming method to be improved by adding the one-to-many KTT approach so as to prompt the local infrastructure developing and to turn small, less educated farmers into larger, competitive farmers. Furthermore, the experience in Miyun County where farmers used ICTs successfully will support the AII to spread the mode to more rural areas of China.

Chapter Seven: Research Summary, Conclusions and Recommendations

Introduction

Since China's economic reforms and the development of ecological agriculture, the national government continuously launched several policies to enhance agricultural development and farmers' capacity. The Agricultural Information Institute (AII) carried out the ICT program in Miyun County since September, 2011. Seventy-one research participants commented on the program from provincial level, knowledge translation or implementing level and grassroots level. The research discovered that the agricultural productivity and farmers' incomes, had to some extent improved, through the development of the program. More and more farmers have understood the importance of a sustainable environment for their farming and livelihoods, and the sprouting of large-scale farming and cooperative management has also emerged in Miyun County.

Research Summary

This research focused on the use of ICTs in Miyun County, China, and identified ICTs' impacts on long term development of Chinese agriculture. Through the research, I identified that the 3G platform for ICTs (smart phones and laptops) provided (1) efficient agricultural information and information exchange settings to farmers, and (2) the agricultural technicians played the key ICT information and training roles in relation to farming activities between the agricultural institutes which are promoters of ICTs and local farmers who are using ICTs, to improve their farming. Third, through open-ended

questionnaires, I further learned from the participants about how they evaluated the introduction of the ICTs and what they expected from the program, the 3G platform and the technicians.

Miyun County is a quite successful county to employ the method, where each village has one agricultural technician who is responsible for the hands-on presentation of the information and technology to farmers. The six towns (34 villages) are mainly distributed in the south and east of Miyun County. Due to the time and financial limitations, the north and west are too far to reach, so the research results are inevitably biased toward the south and east. In the six towns, most agricultural technicians who were professional farmers have richer ICTs and farming experience than the less educated ordinary farmers, and the agricultural technicians were selected by the STC in the villages and they also have land and do farm as the farmers in villages.

The program so far has been presented with some changes in Miyun County through this research. First, the agricultural workers went to farmers' fields to instruct the farmers about new skills. The survey shows that through the development of the program, the produce, incomes and farming skills of farmers were to some extent improved in the view of policy proponents, agricultural technicians and the farmers themselves from 2011 to 2012, particularly regarding pest management and the use of the green fertilizers.

Second, most agricultural technicians helped farmers who focused on pest control. When farmers encountered a new pest problem, the technicians found out ways of dealing with them or ask other experienced technicians or experts to make a distance

diagnosis through the smart phones or laptops which the AII provided to each technician. The research showed that the farmers have relied on ICTs to manage the pests and diseases because most pest management requires some of the most intensive and latest technology.

Third, due to the rich information provided by the 3G platform, agricultural technicians needed to write daily records to report their work or farmers' practical issues. Usually, farmers are faced with a problem which another village has already solved; the technician will see the information and experience to settle the same problem in his/her village by reading about the information on the 3G platform which is a website for agricultural technicians of the AII.

Fourth, the main work of the agricultural technicians is to instruct farmers on how to use the ICTs in their farming activities. Just as in most counties of China, in Miyun County the land activities are done mainly by women and old people because many males and young people go to cities to be migrant workers. There were 19 females out of all of the agricultural technicians interviewed (34 persons) and 15 women out of the local farmers (32 people) in my survey. People around the ages of between 45 and 65 were usually the main labor force. Through the survey, I found that the young agricultural technicians (around 30 years old) are usually quicker to learn and grasp new technological information and have a strong awareness of the environment than older technicians (after 45-year-old).

Not only the developing countries but also the developed countries are faced with the

same problems. Both China and Canada have the same problem that there are too few young farmers in rural areas. It is true that in Ontario Canada, 44% of farmers are 35-54 years old (OMAFA and U-of-G, 2012). The age problem will make it difficult for farmers to access new technologies and form a 'gray' layer for future farming activities.

Fifth, few Miyun County farmers use computers or other modern technological tools and social media in farming. Before the farmers got help from the technicians, a few of them learned about new farming methods by themselves or asked older farmers living in the same village who have more experience. New information and communication were not available to them. After getting help from the agricultural technicians, farmers have had a higher dependence on technicians, such as on selecting seeds and preventing diseases. In order to obtain new information, the farmers understood that the use of modern social media such as computers is essential for their farming.

Many Ontario farmers obtain new information mainly through social media such as LinkedIn, You-tube, Facebook and twitter. According to the survey of OMAFRA and U-of-G (2012), which probably inflates the importance of social media for agriculturalists because it was an on-line survey, 84% of farmers preferred using Twitter and You Tube. Compared with Ontario, in my research county—Miyun County, most farmers are less educated (both agricultural technicians and farmers mostly graduated high school or junior high school.) and only use simple cell phones. For instance, nearly all of the farmers in Canada use smart phones, but in Miyun County, except for the agricultural technicians who use smart phones which were provided by the AII, most farmers only

use the simple functions of cell phones (84%) and only five farmers accessed the computer (table 29).

Due the nature of practical farming activities in agricultural areas, the education level is not the main factor affecting farmers' farming activities. Instead their agricultural experience and the awareness for accessing new information and technologies by using modern social media are more important. However, given such lower education levels and the older ages, the AII found that the diffusion of the agricultural knowledge in rural areas is difficult for such farmers. Hence, the AII requires the technicians to instruct farmers in the fields and expected to introduce KTT to further improve the use of social media among farmers.

Sixth, small operation farmers' farming style is general in Miyun County and even throughout most of China. Small individual farming was flexible for a small village and supporting a family. However, with the economic development and market demands, the small-scale farming method has greatly hindered Chinese agricultural development and wasted social and natural resources.

Seventh, with the help of the agricultural technicians, more farmers understood the benefits of the village cooperatives and were eager to set up efficient village organizations to solve agricultural products supply/demand issues. It is easy for greenhouse vegetable producers to build an organization because vegetable growth is quick and can be consumed fast. One of the agricultural technicians is preparing to use automatic shutter doors for her greenhouse. If the technicians spread such skills in their

villages for the pioneer farmers and lead small households to develop ICTs in farming that is a good way to gradually improve the capacities of all farmers.

Eighth, the SWOT form summarized the opportunities and advantages of developing ICTs in Miyun County. The AII, STC and agricultural technicians will further promote such relative characteristics. Meanwhile, the disadvantages and faults of the program in the year were also presented on the form. According to the points which were presented by experts and technicians in the focus group, the government and institute will associate with other business/research levels or resources to improve both the ICT program and the local infrastructure in Miyun County.

Conclusions

In fact, we cannot conclusively say that farmers who obtained the help of the Information and Communication Technologies (ICTs) program in Miyun County are empowered. However, the findings do indicate that most of those interviewed believe that farmers' capacities are improving in their farming fields.

This research contributes to the theoretical understanding of the relationships among the federal, provincial and grassroots levels, and to the practical application of the ICT tools for less educated, older farmers. An identification of the ages and genders of all participants and an evaluation about responders' agricultural experiences, situations and expectations were made through the research. It also presented how the ICT program improved farmers' agricultural knowledge and production. A new farming method to help farmers to access modern technologies or broad information in their fields was developed

and improved in the project.

The value of the ICT one-to-one method is identified as the ability to encourage both technicians and farmers to get rid of conventional small-scale farming methods. The one-to-one system of extension should be expanded to one-to-many and ideally from many-to-many. Farmers have the ability to learn and use ICTs independently. They also can learn and share their farming experiences among farmers themselves to develop the many-to-many approach. These improvements suggest that for technicians and farmers, no matter how low their level of education is, they are able to learn often difficult scientific terms and knowledge and then improve their own capacities through the ICT tools. At the grassroots level, as long as the government provides modern social media such as smart phones or netbooks in this ICT program in Miyun County, agricultural technicians and farmers themselves are able to use the tools for their farming activities and then further require more extension about other resources such as agricultural market and business. Because the 3G platform provides a chance for technicians to communicate and exchange new information, research respondents believe that the agricultural information and the collection of farming emergencies system efficiently empower farmers either by improving Miyun agricultural production or as the result of better scientific decision-making in the context.

Moreover, the research also suggested that farming activities were managed as an organization by the local and provincial governments. The value of the program is connected to the fact that farmers expected to improve their production and develop

cooperatives with the support of the government. The AII is a federal institute because it's in Beijing and is working with other Provinces such as Xinjiang and Jiangsu, etc. In order to carry out the provincial agricultural program the AII needs Miyun Science and Technology Committee (STC) to actively cooperate. The primary empowerment factor was the STC as a monitoring agency for the agricultural technicians' work whereby the technicians can keep improving their main work. For example, the agricultural technicians' work of the ICT program is measured by the STC with a quarterly feedback system. The co-operation of the STC is a cohesive part of the program of cooperation among the AII and both the agricultural technicians and the farmers, helping to efficiently connect between the decision makers (AII) and the practitioners (technicians and farmers).

The interactions among the AII, the STC and the technicians currently were confined in Miyun County, between the terminal-technicians and the 3G platform managers. There was only a little information about the market supply/ demand, and the program did not consider the farming infrastructure in the local context. Farmers, who can just get farming guidance and new production information from the agricultural technicians, are not provided with good ways to enlarge their land and access other markets without support of finance or cooperatives. On the separate issue of farming, farmers developed an ability to manage their production with ICTs in their small land and livelihoods. The pilot program's values reflected the desire to modernize farmers' agricultural abilities, and to encourage farmers to strengthen their abilities to access modern social media and

other resources so as to maximize using their various resources.

Nevertheless, since the ICT program is a relatively new program implemented in such poor villages, the program has some aspects that impacted agriculture and farmers' further development. It is well known that China's national land policy is unlikely to change soon. It is a challenge for the project to persuade farmers to regard the land as their own so as to encourage them to better understand market needs and cost management. In addition, the program was focused on the transfer of the new technology but not the markets for their produce. The program was limited to teaching farmers about technologies rather than developing other resources such as farmers' education and infrastructure to improve their livelihoods. Such negative aspects of the project affected the ICT program because it did not include either farmers' inside improvement or outside assistance such as from national experts, markets support and international experience.

Overall, the analysis of the ICT program provides a relatively successful method for the development of agriculture in poor rural China so that agricultural technicians and farmers employ new technologies to empower their farming activities. The practical aspect of the project located the positions at the personal, local agency and policy making level. ICTs are an efficient way of encouraging greater access to Chinese literature. The ability of adapting ICTs to farming makes intensive, professional and organized agriculture possible within rural China. Despite agricultural improvement and farmers' capacities having been empowered by the ICTs program in Miyun County, the further development of the program still require the government to add other experienced

methods such as the KTT approach which could help the ICT program by expanding the ICTs into all fields which influence the agricultural activities.

Recommendations

Developing the ICTs so that they can be used to increase agricultural productivity and sustainability is a relatively new project in China. However, with the joint efforts of the Agricultural Information Institute (AII), Miyun Science and Technology Committee (STC), local agricultural technicians and farmers, the ICT program in Miyun County has been relatively successfully implemented. Nonetheless through the research we found there were some things which need to be improved.

To the government

We understand that the agricultural development in Miyun County, even throughout much of rural China, relies on governmental policies. The provincial agricultural institutes and local governments began to implement the policies in rural areas. Through this top-down behavior the national government is able to control the agricultural industry around rural China, but it requires more financial support from the federal Beijing Government and usually makes the appropriate policies for different rural areas. That's why the AII just selected four rural regions to carry out the Information and Communication Technologies (ICTs) project. Following the successful ICT program in Miyun County, the Institute is beginning to consider developing the Knowledge Translation and Transfer (KTT) approach throughout China so that the Government could make both top-down and bottom-up policies considering local organizations' and farmers'

expectations over time.

Rural infrastructure in China such as the drip irrigation system, broadband or television digital box are required to improve farming but such large projects need the provincial and local government to develop them jointly. In view of the mountainous terrains in rural China, satellite devices will be required to enhance data transmission among such regions. And for agricultural development, simpler but more useful farming technologies should be translated and distributed to farmers. Except for the government or institutes such as AII and STC, it is better to involve other social organizations such as agricultural businesses, the call centres or the international community into the program to further improve farmers' farming conditions and integrate resources around their livelihoods. In addition to the 3G platform it is important to integrate and share different resources, information and databases with the users so it is also important for technicians and farmers to access new market or network information. Besides the in-person visits of agricultural technicians transferring ICTs to farmers, farmers' private participation is also essential. That will encourage farmers to expand their own network and market information around them rather than only depending on agricultural technicians or on government policies.

The land policy in China is still a negative factor hindering the promotion of agricultural development; therefore, the national Government needs to reduce the use of the farm land for other uses, such as industry or transportation. The government should also give more benefits to farmers while the farmers' land is used as a public need by

improving land compensation when their land is appropriated by the government for another purpose and encouraging farmers to cooperate with other farmers to obtain more land to do large-scale farming. The government is considering improving ICT agricultural farm methods by adding the one-to-many Knowledge Translation and Transfer (KTT) approach to the existing one-to-one extension method so as to further improve production, and the local infrastructure to help foster a more sustainable agriculture.

Part of the land policy is the Hukou system of household registration which is also a basic national policy for every Chinese person for over 50 years (Foley, 2012). There are situations when farmers work and live in the cities but their Hukou are in villages so they have land; yet, some people who registered in urban areas but are farming in the rural areas do not have land. When the Government adjusts agricultural farm structures or land, those above registrations would affect the reasonable allocation of land and resources so as to cause conflicts of interests or contradictions among neighbourhoods or villages (Liu, 2011). Therefore, the government should reform the Hukou system to give more freedom of living and working either to citizens or to farmers so that the farmers could obtain a better education and health care and be willing to farm in rural areas.

Furthermore, the government needs to make better policies and projects to encourage agriculture among rural farmers and improve their farming subsidy and livelihoods in rural areas. Yet, farmers expect an organization to further integrate the relationships among different levels of farmers to learn using modern social media such as computers, the Internet or social media like twitter to strengthen their ICT abilities. Thus, the local

government needs to stimulate farmers' capacities, especially of older farmers, to enhance modern knowledge so as to arouse farmers to learn and gain access to modern social media and technologies.

In order for the agricultural technicians to play a bridging role in the implementation of the ICT program, the STC not only focuses on in-class training but on robust efforts or practical training as well, such as field trips or experience sharing workshops such as are applied by the KTT program in Ontario.

Since it is easy for empirical knowledge to be transmitted by modern technologies, ICTs are able to encourage farmers to focus on pest management through simple broadcast communication tools, to reduce farmers' crop losses. Moreover, through online diagnosis, the agricultural technicians can contact experts online by using smart phones or laptops while in farmers' fields, and can help poorer and more remote peasants to be able to access experts.

Changing farmers' farming habits and behavior depends on long-term agricultural development and the support of the government and agricultural agencies. In Miyun County, ICTs have improved farmers to access new technologies. In the future, with the improvement of the capacities of farmers, the government and institutes will find it easy to promote more advanced farming approaches such as the KTT, automatic monitoring pest system and market system, and other sophisticated technologies for farmers.

Future Research

This research aimed to explore impacts and insights that the Information and

Communication Technologies (ICTs) were playing in Miyun County of rural China. As a new agricultural method with modern social media which focused on farmers, little research action was started in the area since much literature and research has been concentrated on either technology or production improvement rather than how to reach farmers. These are sometimes referred to as 'last mile' issues. Therefore, this case study is designed to provide a generalization of Kuhn's philosophy of science based on what is directly observed as well as accounting for the effects. Moreover, the program and findings need additional research in order to be able to test some of the above tentative conclusions so that the results can be more confidently generalized to the rest of Miyun County and other parts of rural China which are beginning to use ICTs to enhance farmers' production and sustainability.

The first recommendation for future research would be to explore the impacts of the ICT program in other pilot areas. The AII developed the same ICT program in Jiangsu, Henan and Xinjiang areas of China. Moreover, this research only involved 34 villages which were a small number of Miyun County's 328 villages, and almost all villages accessed were distributed in the south and the east which are closer to Beijing and therefore more accessible. Future work should be involved with more participants, and expand the data both in north and west locations. Through exploring the program in other villages and pilots will help to determine whether the local government or agency was involved in the project or not and if the agricultural technicians did their work as efficiently as they were in Miyun County. That will provide stronger evidence about the

development of such projects throughout rural China.

Another suggestion is to look for the long-term effects on the technicians and farmers who are working with the ICTs. The numbers of the female farmers are almost equal to male farmers in the county and does the ICT program provide easier methods for women to farm their land? With the improvement of the abilities of farmers, are the ICTs that are aimed at the less well educated and inexperienced female farmers able to offer women the opportunity to do the same agricultural activities as males? The findings have indicated that with more and more male farmers migrating to work in big cities, women and old people have often become the main laborers in rural areas. Future surveys should also consider how to transfer complex scientific knowledge and technologies to such people and encourage them to access modern social media.

A final opportunity for future research is to further develop farmers' own capacities combining as much resources as possible such as financial, human and land capitals in different levels that would be able to measure the ICTs' results under social aspects. Currently, the survey on Miyun County was separated from the market and other village agencies. It was a unilateral attempt to identify farmers' work across various social areas where many factors and resources affect agricultural production. By creating a cross-sectional farming network, future research about this program would more deeply probe whether or not the ICTs promote the circulation of agricultural capital and whether farmers, but not a company, are the principal owners of large-scale farming activities.

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Appendix

Questionnaires: The survey of the impacts of ICTs on farming in Miyun County

To investigate the impacts of ICTs in Miyun County. How can ICTs better support farmers' long term agricultural production and identify the advantages or disadvantages of ICTs on farming in this project.

Questionnaire for Policy proponents:

Gender: Male____; Female_____ Date:

1. How old are you?

2. Before becoming involved with the Agricultural Information Institute (AII), what education did you obtain?

3. What is your experience?
   a. Agricultural?
   b. Policy?
   c. Political?
   d. Any other?

4. What is the mandate of the AII?

5. How does AIRI make policy decisions, if at all?

6. Are scientists, technicians and farmers involved in the policy decisions?

7. What is the relationship between the AII, the agricultural technicians and farmers?

8. What training has been provided to the agricultural technicians' in the specific villages of Miyun County?

9. Has this changed over time and if so, how?

10. Why did you choose Miyun County as the pilot to develop the policy?
    a. Is it a more productive agricultural area than elsewhere?
    b. Are the technicians more able, average or less than average compared with other Agricultural Counties?
    c. Are the farmers more productive, average or less than average?
    d. Is the agricultural environment stronger, average or less than farmers in other Counties?

11. What standards did you employ for the agricultural technicians?
    a. Education?
    b. Training?
    c. Experience?

12. Compared with other districts, what outstanding outputs and outcomes are being achieved in Miyun County?
    a. Yields?
    b. Quality of crops?
    c. Diversity of crops?
    d. What are the main crops and/or livestock in Miyun County?
    e. How available are the inputs for Miyun County farmers (fertilizers, quality seeds, pesticides, etc.)?
    f. What is the financial status of farmers in Miyun County?
    g. Are there important social mobility/issues for people in Miyun County?

13. How well do you think the agricultural technicians and farmers do in Miyun County?
14. Do you think the agricultural production outlook is different with agricultural technicians' help?
    a. Improved?
    b. Same?
    c. Worse?
15. What are your expectations for and the long term impacts of the program?

16. What are the changes you have faced in this ICT program? Could you name them?

17. How do you think one can improve this ICT program if at all?

18. What else would you like me to tell you about this pilot program that you think is important but I haven't asked you about?

Questionnaire for Agricultural technicians:

Gender: Male___; Female:____ Date:

Name of village:

How many farmers in the village?

1. How old are you?
2. Before becoming involved with the program, what education did you obtain?

3. What is your experience?
    a. Agricultural?
    b. Marketing?
    c. Your village's affairs management?

d. Any other?

4. What are you expected to do as an agricultural technician with farmers?

5. What training, if any, has been provided to agricultural technicians by the AII or the government?

A. Information application:

a. On open distance learning?
b. The use of Information and Communication Technologies (ICTs)?
c. Internet use?
d. 3G phones?

B. Agricultural production:

a. Techniques in different agricultural or economic crops?
b. Vegetable techniques?
c. Livestock techniques?
d. Agronomy?
e. Aquaculture?
f. Agricultural produce or management techniques?

6. What farming techniques are expected by the government to be improved by the use of cell phones, ICTs and related technologies like laptops and printers?

7. How many of the farmers, if any, in your village have their own:
   a. Telephones?
   b. Cell phones?
   c. 3G phones?
   d. Computers?
   e. Printers?
   f. Internet usage?
   g. TV internet box?

8. What problems did you have when you tried to provide information or introduce technology to farmers?

9. With the help of ICTs, what kinds of capacities are you improved?

10. What kinds of farmers prefer to access or use ICTs?
    a. Large holding farmers?
    b. Small holding farmers?
    c. Educated farmers?
    d. None educated farmers?
    e. Male farmers?
    f. Female farmers?
    g. Young farmers – 50 years old and less
    h. Older farmers - 50 years old and above

11. What changed, if anything, among the farmers when the program was implemented? In other words, what are the outputs and outcomes of this ICTs project so far?
    a. Yields?
    b. Quality of crops?
    c. Diversity of production types– if so, what are they?
    d. The use of the chemical fertilizers, pesticides, increase or decrease?
    e. Status of the incomes of farmers?
    f. Social issues/ mobility?

12. How did you transfer the information or techniques to farmers?

13. How well do you think the farmers did in your village? How well the villagers' attitudes to you?

14. Do you think ICTs will be more important in the long term farming productivity and social mobility? Or has this program met China's agricultural needs for technology?

15. The agricultural technicians as the information terminals, what stories or experiences do you have?

16. Through the program, how do you solve the problems of the agricultural marketing? What's the contribution of the program to agricultural constructions? For example, when you get new information, how do you spread or implement it?

17. According to the quarter feedback system, how do you balance the duties between the local government and the farmers?

18. In terms of your experience, which stage do you think have more problems in early stage, mid-term and later period? How do you solve the problems in different stages?

19. How do you think one can improve this program? List them.

20. What else, if anything, can you tell me about this pilot project that is important but I haven't asked you about?

Questionnaire for Local farmers:

Gender: Male____; Female:_____ Date:

Name of village:

Number of people in household:

1. How old are you?
2. What is the highest level of education you received?
3. What is your farm size?
4. Has your income increased compared to last year? (approximate figure only)
5. Do you usually use phones or computers by yourself?
6. Can you typewrite?

7. How did you learn from the agricultural technicians?

8. Did you increase your income or products through the help provided by the agricultural technician? (example)

9. What do you want to achieve with the help of ICTs?

10. What do you think the long term impacts of the program will be?
    a. Increase yields?
    b. Improve crop quality?
    c. Increase diversity of crops – if so, what are they?
    d. Increase availability of inputs – fertilizers, quality seeds, pesticides, etc.?
    e. Better income?
    f. Social issues/ mobility?

11. How did you get the information before the ICT program was implemented?

12. What's your general evaluation for the agricultural technicians?

13. Do you have any good suggestion or expectation for the agricultural technician?

14. How do you think one can improve this program? List them.

15. Is there anything that you think is important about this ICT pilot program that you would like to mention that I haven't asked you about?