INFORMATION AND COMMUNICATION TECHNOLOGY FOR AGRICULTURE IN THE PEOPLE'S REPUBLIC OF CHINA

NOVEMBER 2019

IFPRI INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

CCAP, PKU

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Foreword

The People's Republic of China (PRC) is the most populous country in the world. Therefore, developments in its agricultural sector can impact the global food security situation. The PRC has succeeded in feeding about a fifth of the global population using less than 10% of the world's arable land. In 2018, the PRC ranked 46th out of 113 countries in the Global Food Security Index survey published by The Economist Intelligence Unit. However, the low arable land per capita and other factors threaten global food security as well as that of the PRC. The PRC has to optimize its production per unit of land using modern technology. ADB and the International Food Policy Research Institute (IFPRI), under the ADB-funded knowledge sharing technical assistance project Investment Assessment and Application of High-Level Technology for Food Security in Asia and the Pacific (KSTA 9218), analyzed how to promote the use of technology and knowledge-intensive agriculture.

Use of information and communication technology (ICT) has increased rapidly in recent years, influencing business development in most countries in the world, including emerging economies. The PRC has been one of the fastest growing economies, exhibiting the rapid expansion of ICT applications over the last decade. E-commerce has particularly flourished in the PRC in recent years. The analysis presented in this report assessed the current situation, growth, and potential of ICT in agriculture in rural areas of the PRC. It also provides policy recommendations to realize the potential of e-commerce and ICT in agriculture in the country.

We hope that this publication provides insights to mobilize investments and undertake policy measures to promote the use of ICT in agriculture in rural areas of the PRC. The findings will also be useful to complement the ongoing initiatives for rural revitalization of the Government of the PRC and serve as a basis to forge effective partnerships and collaborations among stakeholders to ensure reliable supply of affordable and safe food for the PRC and the world.

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The implementation team benefited from the comments and suggestions from several other ADB staff throughout the implementation of the project: Qingfeng Zhang, Director, Environment, Natural Resources and Agriculture Division, EARD; Jan Hinrichs, Senior Natural Resources Economist, EARD; and Xin Shen, Senior Project Officer (Natural Resources and Agriculture), People's Republic of China Resident Mission.

The report is an outcome of the collaboration among ADB, the International Food Policy Research Institute (IFPRI), and the China Center for Agricultural Policy (CCAP), Peking University. Jikun Huang, Director of CCAP and new rural development in Peking University, and vice-president, Jiangxi Agricultural University, led the production of this report. The following members of the country research team from CCAP provided additional research: Min Liu, postdoctoral fellow; Jinxia Wang, Professor; Huayong Zhi, senior research assistant; Song Gao, Master's degree candidate; Huiming Wang, doctorate degree candidate; Shi Min, postdoctoral fellow; and Pengfei Shi, Doctor of Philosophy candidate. Technical assistance from Rowena A. Valmonte-Santos, Senior Research Analyst, and editorial assistance from Lorena Danessi, Administrative and Project Monitoring Coordinator, Environment and Production Technology Division (EPTD), IFPRI is acknowledged. Mark W. Rosegrant, then Director, EPTD, and currently Research Fellow Emeritus, IFPRI coordinated the study.

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Promotion Center, Ministry of Agriculture and Rural Affairs (MARA); Wensheng Wang, Deputy Director General, MARA; Chongjun Tan, Deputy Dean, AliResearch Institute, Alibaba Group; and Kevin Chen, Head of East Asia and Central Asia Office, IFPRI, provided invaluable comments and technical advice on the draft report. Finally, we would like to express our sincere gratitude to the farmers who voluntarily participated in the survey and provided information on different aspects of use of ICT in agriculture in rural areas of People's Republic of China.

Executive Summary

Information and communication technology (ICT) has developed and been adopted rapidly in recent years, influencing business development in the People's Republic of China (PRC). Despite the rapid expansion in ICT application, there are few studies on the status of ICT application and its impacts on the rural economy. This study aims to fill part of the gap by documenting the trends in major applications of ICT, identifying the enabling factors and the major constraints in adopting ICT, examining their likely impacts, and generating policy implications for further development of ICT in the rural PRC. Because ICT application covers wide areas of the rural economy, this study focuses on rural e-commerce and its impacts on farmers.

A review of ICT application in the PRC shows its most rapid expansion occurred in the past decade, beginning 2007. The number of internet users increased from 210 million (a 16% adoption rate) in 2007 to 772 million (56%) in 2017. Mobile phone subscriptions also increased from 50 million in 2007 to 753 million in 2017. The more rapid growth is occurring in e-commerce. The value of online sales in the PRC (1,885 billion yuan) surpassed that of the United States in 2013. By 2016, online sales reached 5,328.8 billion yuan, accounting for about 15% of the country's total retail value for that year. The PRC is now the largest market for e-commerce in the world.

However, internet penetration and e-commerce are not evenly distributed throughout the country. The coastal and more developed provinces have higher rates of internet penetration than other provinces. Expectedly, e-commerce is more developed in the urban rather than rural areas.

To facilitate ICT application in general and e-commerce development in particular in the rural PRC, the government has invested significantly in ICT infrastructure in the rural areas, and provided financial and capacity building support to local people and enterprises to develop rural e-commerce. *Taobao* villages, one type of e-commerce village, is an interesting case worth mentioning. Although it still accounts for only a small part of the PRC's 672,000 villages, *taobao* villages have increased rapidly from 3 in 2009 to 2,118 in 2017. Like other e-commerce businesses, most *taobao* villages are located in the coastal provinces.

The study assessed the uses of ICT and development of e-commerce in the rural PRC using data from two survey rounds conducted by the China Center for Agricultural Policy (CCAP) covering 1,128 households. The CCAP survey is a nationally representative survey in seven provinces across the PRC. In the first-round survey, face-to-face interviews were

conducted in early 2017. The second-round survey was conducted in January 2018 through telephone interviews.

The survey data confirm the significant improvement in rural ICT infrastructure, logistic services, and uses of mobile phones by farmers. In 2017, all villages had access to mobile phone services and about 70% also had access to the internet. More than half of the villages are within 5 kilometers (km) of a national highway. The average distances to the nearest provincial highway and county paved road are 7.5 km and 3.4 km, respectively. In addition to the public postal services, more than one-fourth of villages have package delivery services by private firms. For other villages, the average distance to a package collection or distribution point is 4.5 km. Many farmers have a smartphone and use it extensively. Nearly 90% of adults had a cellphone, with 71% having a smartphone. The major functions of smartphones are for social networking, news, video watching, shopping, and payments.

The surveys also show that agricultural e-commerce is still a new business for farmers, but many farmers are willing to engage in online selling. The proportion of surveyed villages with some farmers engaged in agricultural e-commerce increased from 41% in 2016 to 63% in 2017. However, only 3% of the farmers in the surveyed villages in 2016 were actually engaged in e-commerce, although more than 25% of the farmers were willing to sell their agricultural products through e-commerce. For those not willing to sell online, their main reason was the lack of computer knowledge and skills, storage and preservation facilities, high logistical costs, and required marketing skills.

For agricultural inputs, while online buying rarely occurred, nearly one-fifth of farmers are also willing to buy inputs through the internet. The two major advantages farmers perceived from online purchasing are greater convenience and lower prices. Their main reasons for reluctance include lack of knowledge and skills, poor trust in online transactions, and high uncertainty about quality.

To better understand the impacts of rural e-commerce, this study also conducted an intensive household e-commerce survey in Shandong and Zhejiang, two booming provinces in rural e-commerce. This survey covered 250 households from 20 villages that had nearly 60% of surveyed households involved in e-commerce during 2016–2017. The results show that e-commerce raised farmer's income and self-employment. The price of agricultural commodities sold online is much higher than products sold offline. Although the selling price of products online is generally higher compared to offline selling, farmers gain net profits through online sales. E-commerce also increased farmers' self-employment as online selling is more labor-intensive.

Although the PRC made a significant progress in promoting use of ICTs in rural areas, the agricultural e-commerce made limited progress. Its expansion also faces several challenges. The most frequently mentioned challenge by farmers engaged in e-commerce is the storage and transportation of fresh agricultural products. Due to the limited availability of appropriate equipment, it is difficult to deliver agricultural products across long distances while preserving freshness. As a result, the products suitable for online sale are limited, and so is the range of potential buyers. The second biggest difficulty lies in marketing. Because of information asymmetry associated with

online transactions, which is more severe in agricultural products, the trust of buyers and hence their willingness to buy agricultural products online is still not high. The required investment at the beginning is also high, and usually prohibitive for small farms without external support. Even after successful start-up, meeting standards of customers is still challenging.

Based on the results of this study, several policies are recommended to facilitate application of rural ICT and e-commerce in the rural PRC. These include (i) investing in storage and transportation to support agricultural e-commerce; (ii) investing in farmers' capacity building through practical training on how to undertake e-commerce; (iii) providing financial and credit support to farmers, particularly small farmers, who are engaged in the e-commerce business; (iv) facilitating farmer cooperation so farmers could work together in e-commerce ventures; (v) improving market regulations to provide a favorable market environment for the development of agricultural e-commerce; and (vi) promoting more inclusive e-commerce development in rural areas.

The development of e-commerce is not automatic, nor does it impact different people equally. Regions with better infrastructure and locations are more likely to benefit from e-commerce. Farmers with advanced and relevant knowledge and skills and other resources will benefit more from e-commerce. The government should pay attention to those who may not benefit that much from, or even be hurt by, the development of agricultural e-commerce. Only in this way can the government foster inclusive development in agricultural e-commerce.

Chapter 1
Introduction

Information and communication technology (ICT) has been developing rapidly in recent years, affecting business development in most countries in the world, including emerging economies. According to the International Telecommunication Union (ITU), there has been brisk growth in ICT uptake worldwide over the past decade, with an increase in all indicators (e.g., mobile phone subscriptions, internet access, mobile and fixed broadband subscriptions, etc.).[1] Mobile phone subscriptions reached 6.8 billion by 2013—almost as many as the total global population. Nearly 70% of those in the bottom fifth of the population in developing countries had mobile phones by the end of 2015.[2]

Additionally, more than 40% of the global population has access to the internet. There are major initiatives under way to connect those still unconnected, mostly in rural areas in developing countries.[3] The fast move from using mobile to broadband has also enabled the rapid development of numerous new information and communication channels, such as social media, portable cloud computing, big data, and smart terminals, which are undoubtedly shaping human life.[4] Mobile phone subscriptions are not only changing people's livelihood, transforming how data and information are collected, stored, analyzed, and shared, but also enabling new avenues of doing business online and offline in terms of buying, selling, marketing, and financial transactions.

ICT is expected to play a key role in rural development. In 1984, ITU proposed to eradicate poverty by developing a telecommunications infrastructure. In 2003, in the international congress of information and communication technology and poverty reduction, ICT was used to develop the concept of poverty alleviation. The two World Summit on the Infomation Society conferences held in 2003 and 2005 confirmed that information technology is the means to implement the Millennium Development Goals. A 2009 article argued that the application of ICT had greater effects on education, poverty reduction, and employment opportunities.[5] E-commerce poverty alleviation can improve health, education and human capital, poverty reduction, gender equality, employment opportunity, and community information acquisition conditions. It is widely accepted that

1 ITU. 2013. *Measuring the Information Society: International Telecommunication Union Annual Report.* Geneva. https://www.itu.int/en/ITU-D/Statistics/Documents/publications/mis2013/MIS2013_without_Annex_4.pdf.

2 World Bank. 2016. *World Development Report 2016: Digital Dividends*. Washington, DC. https://www.worldbank.org/en/publication/wdr2016.

3 U. Deichmann, G. Aparajita, and M. Deepak. 2016. *Will Digital Technologies Transform Agriculture in Developing Countries*. World Bank Policy Research Working Paper. No. 7669. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/24507?locale-attribute=fr.

4 Y. Luo, and J. Bu. 2016. *How Valuable is Information and Communication Technology? A Study of Emerging Economy Enterprises.* Journal of World Business. 51 (2). pp. 200–211.

5 Sumanjeet. 2009. *Social Implications of Electronic Commerce.* Journal of Social Sciences. 21 (2). pp. 91–97. November.

the development of rural e-commerce is changing the rural economy and household livelihoods in rural areas of the People's Republic of China (PRC), especially providing an economic advancement opportunity for the people who live in these remote areas.[6] Poverty alleviation through the development of rural e-commerce has been supported by the government, many nongovernment organizations (NGOs), and international development agents.[7]

The PRC has been one of the fastest growing economies in the world, experiencing a rapid expansion of ICT applications over the last decade. The development of e-commerce has also flourished during this time. However, there are few if any quantitative studies on the status and trend of ICT applications in rural areas of the PRC. Based on both secondary and primary survey data, this research study presents the applications of ICT, especially the development of e-commerce in rural areas of the PRC during the last decade. It is noted that there are also emerging cases of online rural financing for agricultural production and agriculture extension services via mobile apps in the PRC, but this study does not cover these topics for the following reasons: (i) these topics were not identified as the focus of this project when the project started; (ii) based on the information collected from about 1,500 rural households in seven provinces in this study, any evidence of farmers using the apps for financing agricultural production have not been found; and (iii) most agriculture extension services via mobile apps are still under the pilot stage and none of these pilot projects were mentioned in the survey samples. Since online financing agriculture and agricultural extension services via mobile apps are interesting areas and may have potential important roles in agricultural production in the future, they merit further study.

[6] G. Lin, X. Xie, and Z. Lv. 2016. *Taobao Practices, Everyday Life and Emerging Hybrid Rurality in Contemporary China*. Journal of Rural Studies. 47 (B). pp. 514–523.

[7] X. Xiong et al. 2017. *The Research on the Path of Poverty Alleviation of E-Commerce: A Case Study of Jing Dong*. Journal of Simulation. 5 (2). pp. 73–79. http://www.journalofsimulation.com/archive/upload/Vol%205,%20No%202%20(2017)/Vol.5,%20No.2,%2073-80,%202017.pdf.

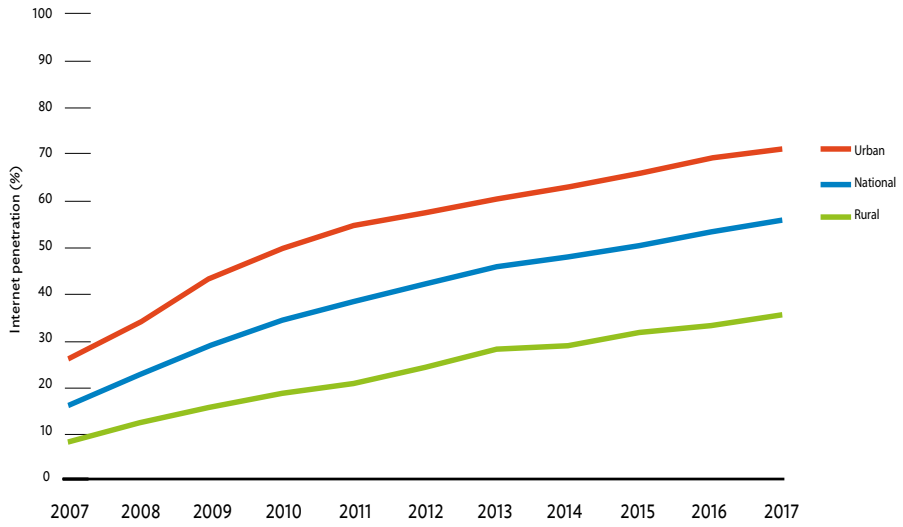
Chapter 2

Applications and Policies of Information and Communication Technology in People's Republic of China

2.1. Application of Information and Communication Technology

The internet has been widely applied in the People's Republic of China (PRC) in the past decade. The rate of internet adoption in the PRC increased from 16% in 2007 to 55.8% in 2017 (Figure 2.1). Figure 2.1 further shows that although the internet adoption rate in urban areas (71%) is higher than the rate in rural areas (35%) in 2017, both rose steadily in the past decade. With this significant increase in the internet penetration, e-commerce is booming in both the urban and rural areas of the PRC.

Figure 2.1: Internet Adoption Rate in the People's Republic of China, 2007–2017 *(%)*



Source: Authors' compilation based on annual reports of the China Internet Network Information Center..

Table 2.1 presents the trends of internet and smartphone users in the PRC. The number of internet users in the PRC almost quadrupled within a decade, from 210 million in 2007 to 772 million in 2017. The table further shows that while rural areas in the PRC started from a lower number of internet users, its growth rate has been higher than the rate in urban areas in the past decade. Compared with the estimated 72% increase of mobile phone subscriptions globally from 2009 to 2016, the PRC's mobile phone subscriptions rose from 50.4 million in 2007 to 753 million in 2017. Mobile phone subscribers almost equaled the total number of internet users in the PRC in 2017.

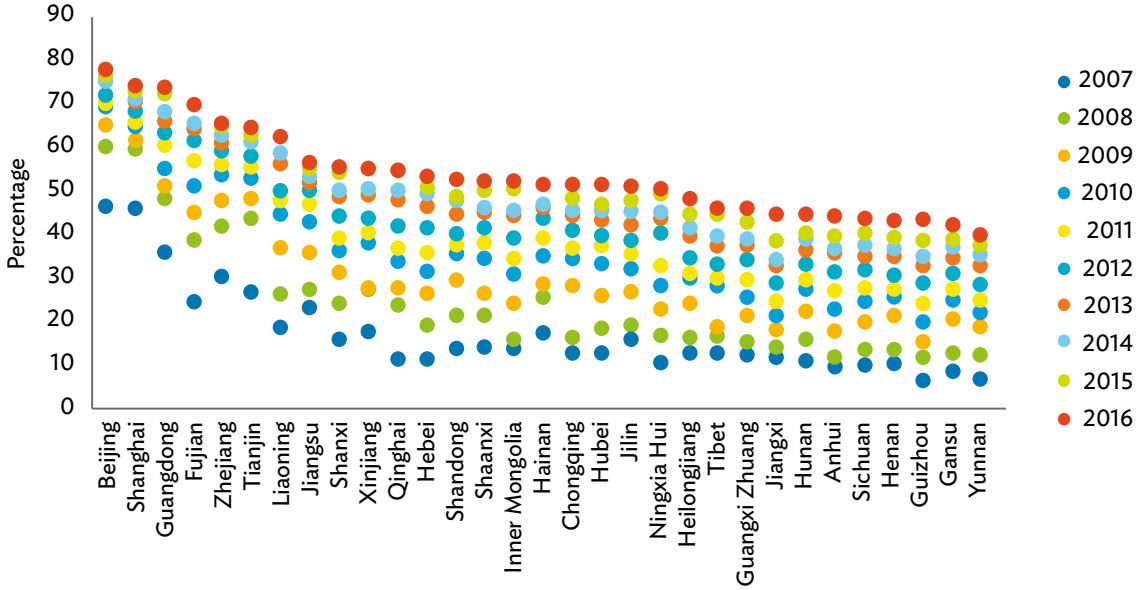
Table 2.1: Number of Internet Users and Share of Smartphone Users in the People's Republic of China, 2007–2017

Year	Internet Users (million)	Internet Users in Urban Areas (million)	Internet Users in Rural Areas (million)	Smartphone Users (million)	Smartphone Users over Internet Users (%)
2007	210.0	157	53	50.4	24.0
2008	298.0	213	85	117.6	39.5
2009	384.0	277	107	233.4	60.8
2010	457.3	332	125	302.7	66.2
2011	513.1	377	136	355.6	69.3
2012	564.0	408	156	420.0	74.5
2013	617.6	441	177	500.1	81.0
2014	648.8	471	178	556.8	85.8
2015	688.3	492	196	619.8	90.1
2016	731.3	530	201	695.3	95.1
2017	772.0	563	209	753.0	97.5

Source: Authors' compilation based on annual reports of the China Internet Network Information Center.

However, internet penetration and internet users are not distributed evenly in the PRC. Figure 2.2 presents the rate of internet use in each province in the PRC. The coastal and more developed provinces (e.g., Beijing, Fujian, Guangdong, Jiangsu, Shanghai, Tianjin, and Zhejiang) have higher rates of internet penetration than other provinces. Nevertheless, all provinces experienced rapid growth in internet penetration in the past decade.

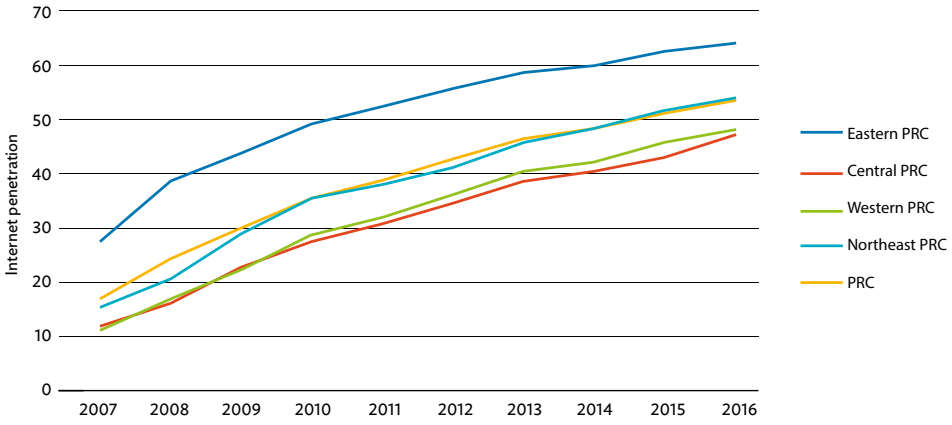
Figure 2.2: Internet Penetration, 2007–2016 *(%)*



Note: Data are not available for 2017.
Source: Authors' compilation based on annual reports of the China Internet Network Information Center.

Figure 2.3 presents the growth of internet adoption in the PRC from 2007 to 2016. The eastern region leads the other regions in the PRC in rate of internet access. The high rate of internet penetration in the northeast region is consistent with the country average, while internet penetration in the central and western regions is lower than the average.

Figure 2.3: Growth of Internet Adoption in the People's Republic of China, 2007–2016 *(%)*



PRC = People's Republic of China.
Source: Authors' compilation based on annual reports of the China Internet Network Information Center.

E-commerce has also developed rapidly in the PRC in recent years. While the first online transaction was recorded in April 1998, its expansion was slow before 2007.[8] By 2008, the total value of online sales was 130 billion yuan (CNY), which accounted for only 1.3% of total retail sales in the PRC. However, e-commerce in the PRC has demonstrated very rapid growth since 2008. Based on the annual monitoring report of its online retail sales, the total value of online sales increased from CNY130.0 billion in 2008 to CNY5,328.8 billion in 2016. The share of online sales over the total retail sales increased from 1.3% to 14.9% over the same period.[9] In 2013, the total value of online sales in the PRC reached CNY1,885 billion, which surpassed total online sales of the United States. The PRC has become the largest market for e-commerce in the world thereafter. The number of online shopping members increased from 7.9 million in 2008 to 50 million in 2016.

While online sales occur mainly in urban areas, it has also emerged in rural areas. The value of online sales in the rural PRC rose from CNY353.0 million in 2015 to CNY482.3 million in 2016, accounting for about 9% of online sales of the country in 2016. After the successful development of the online market in urban areas, many e-commercial enterprises have started to explore market expansion in rural areas. For farmers, e-commerce includes buying goods and selling their products through the internet. The development of rural e-commerce is expected to change the economy

[8] L. Cao, and Z. Zhang. 2009. Research Report of the Twelve Years of China's E-Commerce:1997–2009. http.//tech.qq.com/2009921e/ebaogao.doc.
[9] China E-commerce Research Centre. 2016. The Annual Monitoring Report of Online Retail Sales of China.

and household livelihoods in the rural PRC, providing an economic advancement opportunity for the people who live in these remote areas (footnote 6). E-commerce has also been incorporated into rural poverty alleviation programs by the government and many nongovernment organizations (footnote 7).

2.2. Supporting Policies

Table 2.2 presents the PRC government's support to ICT application in rural areas. Using various key words,[10] this study sought to find all of the related policies and official documents that have been released by the State Council on its public website. The results show that the government has paid increasing attention to developing internet penetration and adoption in rural areas of the PRC since 2006, especially in recent years. The government has also made efforts toward the development of e-commerce and e-commerce application in rural areas of the PRC since 2012. The same is true for Internet of Things agriculture-related applications since 2010.

Table 2.2: Frequency of Key Words Used in National Policy Documents Issued by the State Council of the People's Republic of China, 2006–2017

Year	Internet	Rural Internet	E-Commerce	Rural E-Commerce	Internet of Things in Agriculture
2006	12	8	2	2	0
2007	15	8	2	2	0
2008	8	2	2	2	0
2009	10	8	4	4	0
2010	13	5	4	4	2
2011	23	18	6	3	9
2012	20	14	14	10	12
2013	22	9	8	6	12
2014	31	15	23	13	9
2015	75	38	51	24	24
2016	90	50	40	25	22
2017	81	42	30	16	19

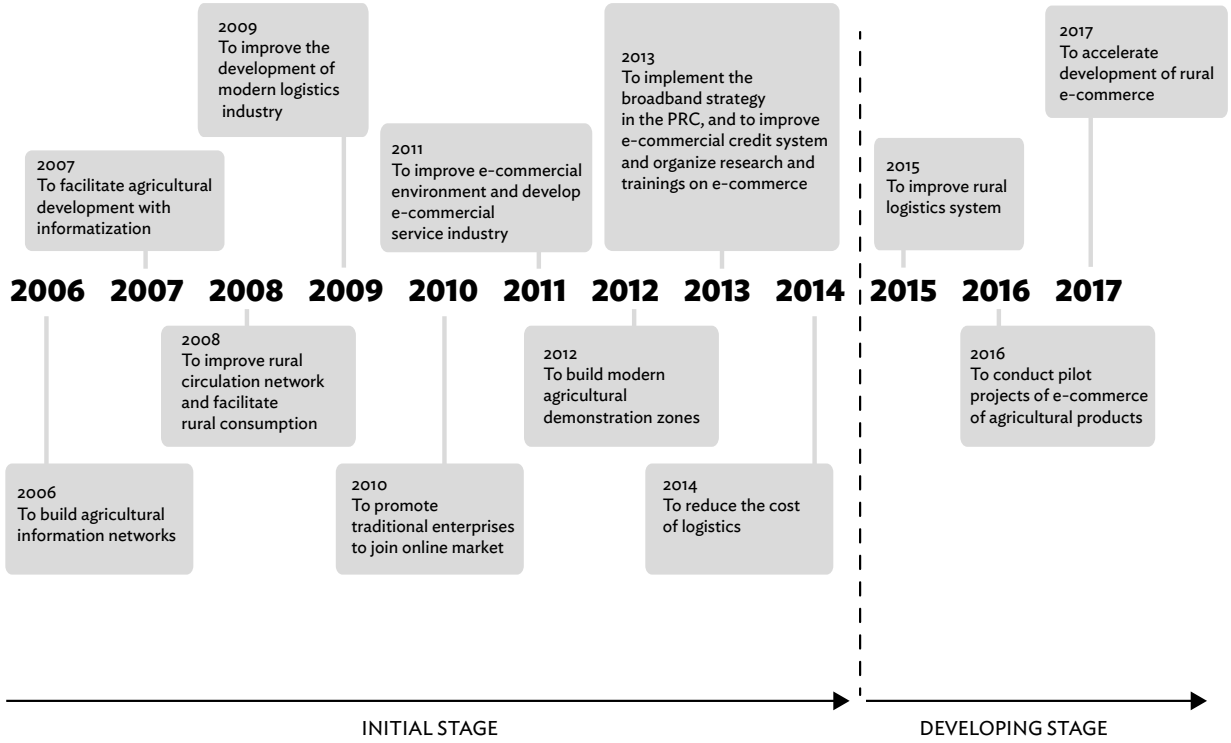
Source: Authors' compilation based on Government of the People's Republic of China. www.gov.cn.

There have been many policies and official documents on ICT application in the rural PRC released by the national and local governments. Considering the development of e-commerce as a major part of ICT application in the PRC, this study focused on the policies and official documents that support the development of e-commerce in the rural PRC from 2006 onward. Figure 2.4 presents the main

[10] The key words used were: "Internet," "Internet in the rural PRC," "e-commerce," "e-commerce in the rural PRC," and "Internet of Things application in agriculture."

concerns of the government on promoting rural e-commerce year from 2006 to 2017. The development of rural e-commerce in agriculture has notably been given more emphasis in recent years.

Figure 2.4: Main Content of National Policies and Official Documents on E-Commerce Development in Rural Areas of the People's Republic of China, 2006–2017



Sources: Authors' compilation based on websites of the State Council of China, Ministry of Agriculture and Rural, Ministry of Commerce, and Ministry of Industry and Information Technology.

Government support thus focuses on the following areas related to the infrastructure and building of the soft environment:

(i) **Infrastructure.** The government announced its "Strategy of Broadband" in 2013. It aims to update the broadband internet and increase the internet access all over the country, especially in rural areas. Local governments have included network construction in their local developing plans and correspondingly provided financial support. The government has focused on improving the infrastructure for collecting agricultural products, storing, processing, shipping, and marketing, to provide the necessary environment for developing e-commerce.

(ii) **Soft environment.** Building the soft environment focuses on providing local people and enterprises with training and platforms for developing

e-commerce. For example, migrant workers who were working in big cities are encouraged by local governments to return to their hometowns to start e-commercial businesses by providing them with funding and loans with low interests. Similar financial support is provided to agricultural enterprises and farmer cooperatives. Trainings on how to start and operate e-commerce has been organized by different bureaus of local governments. In addition, e-commercial parks for clustering of local e-commercial entrepreneurs are being developed. They are used for helping the new enterprises to run e-commerce. Specifically, the local government builds e-commercial parks and the new enterprises get the opportunities to rent office space in these e-commercial parks at a low rate or for free. At the village level, the project of "one product for one village" has been implemented. This aims to develop typical product(s) for each village, which would also help to reach a critical mass of products from villages for selling through the internet.

Based on the changes in e-commerce and the level of government support in the rural PRC, the development of rural e-commerce can be divided into two stages. Before 2014, the PRC's rural e-commerce was at the initial stage. While many e-commercial enterprises started to explore the rural e-commercial market, little investment had been made. As e-commerce is mainly experienced in urban areas, support for e-commerce in agriculture and rural areas from governments was initiated only recently. After 2014, e-commerce in the rural PRC started to emerge. Both national and local governments increased their efforts to develop rural e-commerce. These include investments in infrastructure such as transportation, internet, and logistics. After 2014, enterprises also invested significantly in the rural e-commerce market.

Chapter 3

Major Applications of Information and Communication Technology in Marketing and Agriculture in Rural Areas

3.1. Taobao Villages

Over the past decade, e-commerce has spread throughout the PRC and provided new opportunities for rural development. The *taobao* village is a typical example of this development. An initiative of Alibaba Group Holding Limited, *taobao* villages can potentially play a key role in rural development in the future (footnote 6).

3.1.1. Expansion of Taobao Villages

Taobao business started in the urban areas due to internet access and availability. With the rapid expansion of internet access in rural areas in recent years and significantly lower costs of labor and renting fees of office building and storages, Taobao sellers have expanded their business from urban to rural areas.[11]

According to AliResearch, Alibaba's research institute, *taobao* villages have to meet the following requirements: (i) the village should be located in a rural area; (ii) the total annual turnover on the Taobao platform should exceed CNY10 million; and (iii) there should be more than 100 active online stores, or at least 10% of the households in the village are operating online stores.[12] To have a better understanding the roles of *taobao* villages in agriculture, in this report, *taobao* villages are divided into the following two categories: (i) agricultural *taobao* villages that primarily sell agricultural commodities and/or processed agricultural and food products; and (ii) nonagricultural *taobao* villages that primarily sell industrial products, such as electric appliances, clothes, shoes, etc.

Table 3.1 presents the number of *taobao* villages in 2009–2017. Although *taobao* villages accounted for a small part of the PRC's villages, they have expanded rapidly and increased from 3 in 2009 to 2,118 in 2017.[13] There had been no agricultural *taobao* village until 2012, but by 2017, there were 93 agricultural *taobao* villages. Table 3.1 also shows that the significant rise in the numbers of total and agricultural *taobao* villages is consistent with the overall trend of rural e-commerce development in the PRC.

[11] X. Chen, L. Zhang, and W. Li. 2014. *A Network Evolution Model for Chinese Traditional Acquaintance Networks.* IEEE Intelligent Systems. 29 (5). pp. 5–13.

[12] Aliresearch. 2016. Research Report on China's Taobao Villages. http://www.aliresearch.com/en/news/detail/id/21298.html.

[13] There were 671,729 administrative villages (or villages) in the PRC in 2016. By 2017, *taobao* villages accounted for about 0.3% of total villages.

Table 3.1: Number of Taobao Villages and Agricultural Taobao Villages, 2009–2017

Year	Taobao Villages	Agricultural Taobao Villages
2009	3	0
2012	16	1
2013	20	3
2014	212	8
2015	780	40
2016	1,311	62
2017	2,118	93

Source: Authors' compilation based on data from Alibaba and National Bureau of Statistics of China. various years. China Statistical Yearbook. Beijing..

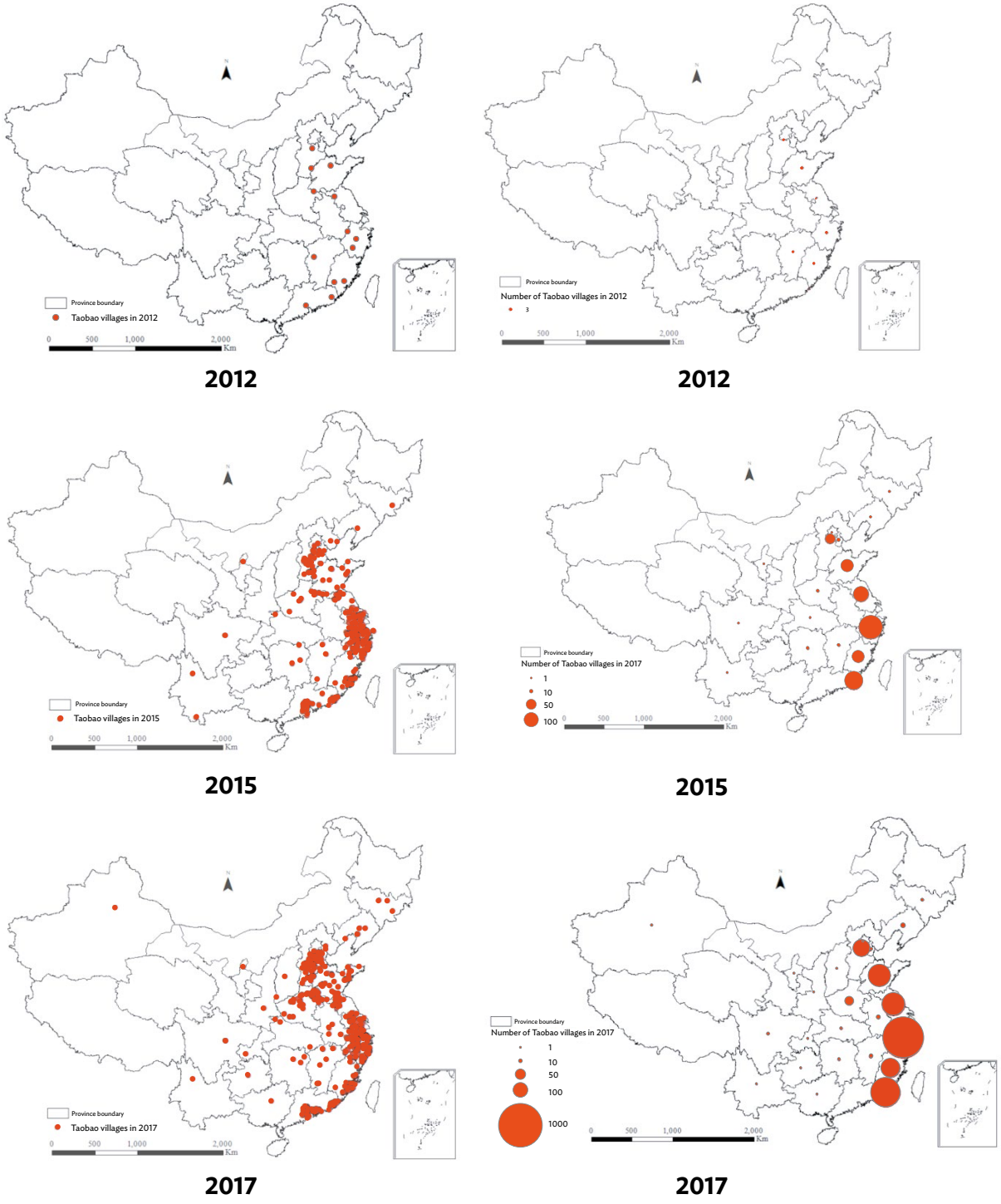
While *taobao* villages are still at an early stage of development, clustering is occurring. Similar to the conventional industrial clusters in developing countries (e.g., the cotton knitwear industry in Tiruppur of India and the shoe industry in Sinos Valley of Brazil[14]), the clusters start and produce their commodities in low-cost regions or counties, and then sell them to more developed regions. In the PRC, *taobao* village clusters start in specific rural areas and sell their products mainly to the buyers in urban areas. The difference is that *taobao* village businesses rely on e-commerce platforms and the internet to sell their commodities. Sellers do not have physical stores and hire only a few employees to sell their products. These relatively low-capital requirements significantly reduce the entry barrier for individuals and entrepreneurs to starting a business. In addition, the e-commerce platform provides the businesses access to not only regional but also national markets, which helps the e-commerce shops to have more opportunities to expand their markets.

3.1.2. The Spatial Distribution of Taobao Villages

Map 3.1 shows the spatial expansion of *taobao* villages in 2012, 2015, and 2017. In 2012, *taobao* villages were developed only in seven provinces (Fujian, Guangdong, Hebei, Jiangsu, Jiangxi Shandong, and Zhejiang). In 2017, there were *taobao* villages in 24 provinces. It is interesting to note that the provinces with early development of *taobao* villages tend to have a faster development of *taobao* villages (e.g., Guangdong, Jiangsu, Shandong, Zhejiang). Of the total number of *taobao* villages, 96% were in these six provinces.

[14] Cawthorne. 1995. *Of Networks and Markets: The Rise and Rise of a South Indian Town, the Example of Tiruppur's Cotton Knitwear Industry*. World Development. 23 (1). pp. 43–56; H. Schmitz. 1995. *Collective Efficiency: Growth Path for Small-Scale Industry*. Journal of Development Studies. 31 (4). pp. 529–566.

Map 3.1: Spatial Distribution



Panel A: Locations of Taobao Villages

Panel B: Number of Taobao Villages by Province

Source: Authors' compilation based on data from Alibaba.

3.2. Operating Modes of E-Commerce in Rural Areas

The development of *taobao* villages is only one typical example of e-commerce development in the rural PRC. This subsection describes the other modes of e-commerce based on surveys in three counties (Jiaxiang, Longkou, Qixia) in Shandong and two counties (Linan and Yiwu) in Zhejiang in 2017 and 2018. The survey aimed to understand the current status of ICT applications in the rural PRC. The survey focused on e-commerce since this is where ICT is primarily used in business in rural areas. This subsection briefly summarizes the types or modes of e-commerce in the rural PRC. Detailed discussions on the survey data are presented in the succeeding sections. The use of drones in agriculture, a recent development, is briefly discussed at the end of this section.

Based on the surveys, the current rural e-commerce in agriculture is mainly operated in the following ways:

(i) **Farmers sell their own products or the products they collected from others.** The products farmers sell are the local dominant commercial crops, such as apples in Qixia and pecans in Linan. Farmers also sell agricultural products that are processed by local factories. During the field survey in *taobao* villages, some online sellers also collected the products from other farmers and sold them online. The farmgate prices received from online sellers were similar to those sold to wholesalers at the same local village. Farmers who sold their products to online sellers did not have information on marketing costs and online selling prices. Thus, this market channel could not be examined in the marketing cost and price analysis presented later.

(ii) **Food enterprises and farmer cooperatives sell the agricultural products and/or the processed products.** There are two types of e-commerce enterprises and cooperatives. The first is the traditional enterprises and cooperatives that sell their products mainly through their physical channels but have also started to use online selling as an alternative way to expand their sales. The second type is the e-commerce enterprises and cooperatives whose main business is to operate online selling.

Farmers, enterprises, and cooperatives sell their agricultural products mainly through the following modes:

(i) **Sell agricultural products through popular e-commerce platforms such as Taobao, Tmall, Jindong, WeChat, etc.** This mode is often used by food enterprises and farmer cooperatives. They also sell wholesale through Alibaba and other wholesale platforms. However, individual farmers rarely sell their products through the above platforms because of the high thresholds, such as the official documents and investment to run online stores.

(ii) **Sell agricultural products through WeChat.** This is becoming more popular for small farmers to sell their products because this platform has a lower threshold and entails low costs to operate; however, the potential buyers are limited by the nature of the WeChat network.

(iii) **Sell agricultural products through their own platforms.** This is mainly used by the large marketing enterprises and the enterprises specializing in e-commerce. For example, China Post and Supply and Marketing Cooperatives, a state-owned enterprise, which has the largest logistics system and is able to reach almost all villages in the PRC, has developed Ule since 2012.[15] Ule cooperates with the physical groceries in the villages and sets their platforms in the groceries. It helps the villagers to purchase the goods from the Ule website, withdraw small cash from grocery owners, and pick up packages from groceries. Food enterprises and farmer cooperatives are required to have legal certificates to be able to sell their products on the Ule website. Moreover, Ule also collects some special agricultural products from the farmers or farmer cooperatives and lets them sell personally on their platform.

(iv) **Sell agricultural products through the regional platforms that serve the local residents.** This is mainly operated by the private companies. They purchase agricultural products from the local wholesale market or farmer cooperatives and send the products to their consumers who order from their online platform. Regional platforms develop well and quickly because of the perishability of agricultural products and inconvenience in the long-distance delivery.

3.3. Application of Drones in Agriculture

The survey about the application of drones in agriculture was conducted in Jiaxiang county in Shandong province. The county has about 84,000 hectares (ha) of crop land. The dominant crops are wheat and soybean, and most are planted by small farms. In 2016, drones were used to spray insecticide to around 6,600 hectares of crop areas. This land area is considered to have expanded since.

Based on interviews with local officials, companies, and farmers, the survey found that local retailers of pesticides play an important role in the adoption of drone technology in crop pest control. The companies or drone owners who provide drone services find the customers (farmers) through local pesticide retailers, and retailers sell their pesticides to the farmers or cooperatives who receive the drone services. In this case, the spread of drone custom service reduces the searching costs for finding the targeted farmers.

[15] P. Zhu. 2016. A Study on the Dilemma and Solution of the Development of E-Commerce in Rural China.

Although the cost of using drones to spray insecticide is double that of the manual method, the speed and effectiveness of pest control are improved. Because of the speed in which it is able to apply agricultural inputs, drone use in agriculture can help prevent the spread of acute plant diseases and pests. Drones use less pesticides and only use a tenth of the water that is traditionally required by manual spraying, reducing ecological and economic losses. In soybean production, ripe soybeans would be damaged when pesticides are manually sprayed. This does not occur when using drones to spread pesticides during the late stage of soybean growing season.

However, drones work best at a larger scale, so expanding its use for small farmers is still a challenge. Realizing this issue, local governments in many provinces (e.g., Fujian, Henan, Jiangxi, Shangdong, etc.) have initiated supporting policies to expand drone application in agriculture. For example, Henan province first started to provide a subsidy to farmers who buy drones for crop plant protection in 2014. Fujian, Hunan, Jiangxi, and other provinces followed later. At the national level, the Ministry of Agriculture and Rural Affairs has also recently proposed to subsidize farmers for purchasing crop protection drones. A national subsidy policy for crop protection drones will likely be initiated soon.

Chapter 4

Access to Information and Communication Technology Infrastructure Based on Survey Data

4.1. Sampling Approach and Data

To assess the uses of ICT and development of e-commerce in the rural PRC, the China Center for Agricultural Policy (CCAP) conducted three survey rounds on rural labor and labor. The first round was conducted in February 2017 in seven provinces. These seven provinces belonged to two CCAP province categories: the first was covered by a rural labor and land survey started in 2000, and the second was covered by a rural farm size and productivity survey. There were five provinces from the first type: Zhejiang (east), Hubei (central), Guangdong (south), Shaanxi (northwest), and Sichuan (southwest). The other two provinces are from Henan and Shandong, representing the northern region.

The CCAP used the stratified random sampling approach to select the survey samples in the rural labor and labor survey. During sampling, all counties in each province were arranged in descending order of gross value of industrial output (GVIO) per capita, and then divided evenly into five groups. One county was randomly selected from each group. Within each sample county, the same procedure was applied to select two townships based on GVIO per capita. In each township, one administrative village was randomly selected. Within each village, 20 households were randomly selected. In these 5 provinces, there were 25 counties, 50 townships, and 50 villages in the sample. In Henan and Shandong, CCAP also used the stratified random sampling approach but based on the area of cultivated land per capita. CCAP ranked all counties in descending order of area of cultivated land per capita in each county within a province, and then all counties were divided evenly into three groups. One county was randomly selected from each group. In each county, two townships were selected using the same procedure, which was also applied to select two villages from each township. With each village, 10 households were randomly selected. While the sampling approach of Henan and Shandong differs from the other five provinces, data from each province does represent the population.

Table 4.1 briefly presents the situation of rural e-commerce development in the seven surveyed provinces. It indicates that 3% of the households selling agricultural products used online sales in 2016. Among these provinces, Zhejiang has the highest (10%). The survey also shows that 18% of farmers were willing to sell their products through online sales.

Table 4.1: Shares of Households Selling Agricultural Products and Selling through E-Commerce and the Willingness to Sell Online, 2016

Province	Number of Observations	Households Selling Agricultural Products (%)	Households Selling Agricultural Products Online (%)	Not Selling Online	
				Willing to Sell Online (%)	Unwilling to Sell Online (%)
Total	**1,128**	**73**	**3**	**18**	**52**
Shaanxi	178	84	2	27	55
Zhejiang	159	56	10	4	42
Sichuan	189	57	3	17	37
Hubei	193	83	1	23	59
Guangdong	193	56	1	9	46
Shandong	105	97	0	30	67
Henan	111	99	4	30	65

Source: Authors' compilation based on data from the first-round survey on e-commerce of the China Center for Agricultural Policy.

Face-to-face interviews were conducted for each village and household. The survey collected information on demographics, access to internet, possession and use of smartphones, agricultural production, and sales. In addition to household surveys, officials at county and township levels were interviewed to discuss the policy issues on e-commerce. The survey team also visited some e-commerce enterprises and learned their views on the development of e-commerce, including its advantages and disadvantages; the challenges they face and opportunities they see; the support they need, etc.

The second-round survey was conducted in January 2018 through telephone interviews. Village leaders who were surveyed in our first-round survey were interviewed over the phone to learn the changes in the development of local e-commerce since the last survey in 2017. Table 4.2 presents the findings of these interviews. The results show that the villages that operate e-commerce increased from 41.1% in 2016 to 62.9% in 2017. About two-fifths of these villages (26.6% versus 62.9%) had online sales of agricultural products in 2017. It is worth noting that based on the village leaders' personal assessment, the percentage of households that had e-commerce operation in our sample was only 0.54% in 2016 and 1.81% in 2017 (Table 4.2). However, the household sampling survey data showed that this was 3% in 2016 (Table 4.1). This difference may be due to a lack of awareness of local leaders about individual farmers who sold a small quantity of their products through WeChat.

Table 4.2: Villages and Households Operating E-Commerce, 2016 and 2017

Province	Number of Villages	Villages Operating E-Commerce (%)		Villages Selling Agricultural Products Online (%)	Households Operating E-Commerce (%)	
		2016	2017	2017	2016	2017
Total	**124**	**41.1**	**62.9**	**26.6**	**0.54**	**1.81**
Shandong	12	41.7	58.3	0.0	0.64	0.83
Henan	12	25.0	75.0	50.0	0.26	1.06
Shaanxi	20	55.0	80.0	30.0	0.77	2.66
Zhejiang	20	70.0	75.0	25.0	0.96	5.61
Sichuan	20	25.0	65.0	40.0	0.44	1.40
Hubei	20	35.0	50.0	20.0	0.21	0.44
Guangdong	20	30.0	40.0	20.0	0.49	0.69

Source: Authors' compilation based on data from the second-round survey on e-commerce of the China Center for Agricultural Policy.

The third-round survey was conducted in March 2018. To better understand the development of rural e-commerce in the PRC, Shandong and Zhejiang were selected. These two are typical and booming areas for developing rural e-commerce based on secondary data on *taobao* villages and online business. According to the extent of rural e-commerce development and the main products, Qixia and Feicheng counties were selected as sample counties in Shandong province; and Linan, Suichang, and Jiangshan counties as sample counties in Zhejiang province. At the village level, two e-commerce villages and two villages without e-commerce were selected for matching in each county if these villages sell the same kind of agricultural products, and comparing the levels of economic development. E-commercial villages are the villages where e-commerce has been developed well, like *taobao* villages. Eight villages (four e-commerce villages and four non-e-commerce villages) were selected in Linan county because agricultural e-commerce was more developed in these counties. At the household level, 15 households were selected in each e-commerce village, and of these, 10 households have operated e-commerce (called e-commercial households) and 5 households have not (called non-e-commercial households). Meanwhile, 10 households were randomly selected from each non-e-commerce village. As a result, the survey selected five counties, 20 villages, and 250 households from Shandong and Zhejiang. Table 4.3 shows that 58.8% of the households were operating e-commerce during 2016–2017, and 79.2% of households were willing to sell their products through the internet.

Table 4.3: Samples and Percentage of Households Operating E-Commerce and Their Willingness to Sell Online in Zhejiang and Shandong, 2016–2017

Province	Observations	Sell Online (%)	Willing to Sell Online (%)	Unwilling to Sell Online (%)	No Opinion (%)
Total	**250**	**58.8**	**79.2**	**18.4**	**2.4**
Zhejiang	150	60.7	71.3	24.7	4.0
Shandong	100	56.0	91.0	9.0	0.0

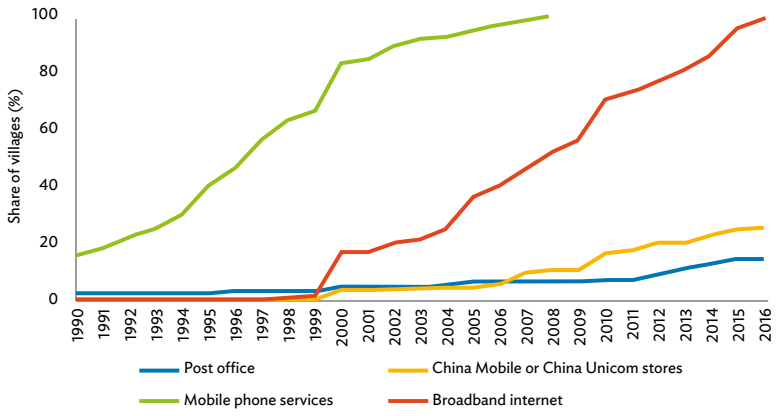
Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

Based on the nature of the three datasets, the first-round survey is used to present the general situation of e-commerce development in the PRC, and the second-round is used to present the changes in the development of rural e-commerce from 2016 to 2017. The third-round case study and survey specifically present the development of rural e-commerce in a typical area, which is used for a more detailed study of the e-commerce in more developed e-commerce regions.

4.2. Infrastructure at the Village Level

Our survey shows that in general, ICT infrastructure, as well as other infrastructure for e-commerce, has been well developed. By 2016, 25% of the sample villages had a business office opened by the China Mobile (CMCC) or China Unicom (Unicom), two major providers of mobile phone services in the PRC (Figure 4.1). All villages in the sample have access to mobile phone services. Mobile phone services expanded rapidly in late 1990s. The villages that had access to mobile phone services reached 83% in 2000 and 100% since 2008. Broadband internet access has also experienced fast growth since 2000. By 2010, 70% percent of the villages had access to this service. Except for one village, all the others had been covered by 2016.

Figure 4.1: Development of Information and Communication Technology Infrastructure in Rural Areas of the People's Republic of China, 1990–2016 (%)



CMCC = China Mobile.
Source: Authors' compilation based on data from the first-round survey on e-commerce of the China Center for Agricultural Policy.

Transportation infrastructure is important for e-commerce development and is also being rapidly developed in rural areas of the PRC. National highways pass by 13 villages in this study's sample. More than half of the villages (66 out of 126 villages) are within 5 kilometers (km) of a national highway. An additional 25 villages are within 10 km. Only 13 villages are farther than 20 km from a national highway. The average distance to the nearest national highway is 10 km in the sample villages. The distances to the nearest provincial highway is 7.5 km and 3.4 km to a county paved road.

Logistics services are also available in some of the sample villages. The share of villages with a post office increased from 2% in 1990 to 15% in 2016 (Figure 4.1). About 60% of the sample villages are within 5 km of a post office. Only 6% are farther than 10 km from a post office. The average distance to the nearest post office is 4.7 km. Among the villages without a post office, 44% (or 47 villages) have one or more postal workers who deliver mail and packages for villagers. Private providers of package delivery were also found in the sample villages—26% of them (33 villages) have package delivery services by private firms. In addition, 51% of them (64 villages) are within 5 km of a package collection and distribution point. The average distance to the package collection and distribution point is 4.5 km.

4.3. Access to and Use of Information and Communication Technology by Individuals

According to the data from CCAP's first-round survey, 89% of rural residents have mobile phones in 2017. The share of women with mobile phones is 84%, lower than the share for men (93%), but still high. Only 69% of people aged 60 or above have a mobile phone. The share of mobile phone owners who received elementary education or fewer (0–6 years of schooling) is 77%, about 20% lower than the share for people who received more than 6 years of schooling. At the household level, 99% households have at least one mobile phone. The average number of mobile phones per household is 3.4. About 70% households have two to four smartphones. Smartphones are popular among rural people too (Table 4.4). For people aged 16 or above, 71% have a smartphone. This share is similar between men and women. By age, the share is very high for people aged 16–45 (higher than 95%). This share drops sharply for people aged above 45. For people aged 46–60, the share of smartphone owners falls to 58%, and further drops to 14% for people aged above 60. The ownership of smartphones also varies with education level. For people who received elementary education or less, only 42% have a smartphone. This share jumps to 81% for those who received junior middle school (7–9 years of schooling), and 92% for those who received more than 9 years of schooling. When measured at the household level, 87% of them have at least one smartphone. The average number of smart phones per household is 2.4. About 70% households have two to four smartphones. As the data show, in 2017 in two provinces, nearly all the indicators are slightly higher than the average of seven provinces in 2016, which is in line with the survey team's expectations, since the development of e-commerce in Shandong and Zhejiang is relatively faster than other provinces.

Table 4.4: Share of Rural Residents Aged 16 or Above with Mobile Phones and Smartphones, 2016–2017

Description	2016[a]			2017[b]	
	Number of Observations	With Mobile Phone	With Smartphone	Observation	With Smartphone
Total	**4,833**	**89**	**71**	**906**	**76**
By gender					
Male	2,500	93	72	447	79
Female	2,333	84	70	459	72
By age					
16–30	1,214	95	98	186	93
31–45	1,225	98	95	249	99
46–60	1,253	92	58	290	79
Above 60	1,141	69	14	181	20
By education					
Elementary school or lower	1,800	77	42	231	38
Junior middle school	1,784	97	81	305	82
High school or higher	1,249	95	92	370	94

[a] For seven provinces: Guangdong, Henan, Hubei, Shaanxi, Shandong, Sichuan, and Zhejiang.
[b] For two provinces: Shandong and Zhejiang.
Source: Authors' compilation based on data from the first- and third-round surveys on e-commerce of the China Center for Agricultural Policy.

If we focus on the decision makers on agricultural production and sales, the ownership of mobile phones exhibits similar patterns to that of all the persons aged above 16. But the story of smartphones differs by age. Only 47% of decision makers had a smartphone in 2016 in the seven provinces, compared to 82% of all the persons surveyed in 2017 in two provinces (Table 4.5). Both men and women decision makers own fewer smartphones than people in general. The share of smartphone owners in decision makers aged 45 or below is lower than their counterparts. This share stays low for decision makers aged 45 above and is similar for all the persons in the same group. Although lower than the entire sample, the share of smartphone owners increases as the number of years of schooling increase. For decision makers who received elementary education or less, only 30% have a smartphone. This share increases to 59% for those who received junior middle school (7–9 years of schooling), and 68% for those who received more than 9 years of schooling. These numbers suggest that the lower share of smartphone owners in decision makers on agricultural production and sales is because they are older and received fewer years of schooling than the entire sample.

Table 4.5: Shares of Decision Makers on Agricultural Production and Sales with Mobile Phones and Smartphones, 2016–2017

Description	Number of Observations	2016[a] With Mobile Phone	2016[a] With Smartphone	2017[b] Observation	2017[b] With Smartphone
Total	**1,503**	**92**	**47**	**391**	**82**
By gender					
Male	1,067	94	48	262	80
Female	436	86	45	129	87
By age					
16–30	9	100	89	39	100
31–45	196	97	87	115	100
46–60	717	95	58	172	87
Above 60	581	84	15	65	28
By education					
Elementary school or lower	732	86	30	88	53
Junior middle school	584	97	59	155	85
High school or higher	187	97	68	148	97

[a] For seven provinces: Guangdong, Henan, Hubei, Shaanxi, Shandong, Sichuan, and Zhejiang.
[b] For two provinces: Shandong and Zhejiang.
Source: Authors' compilation based on data from the first- and third-round surveys on e-commerce of the China Center for Agricultural Policy.

This result can be confirmed by the reasons why they do not use smartphones. The primary reason is "Don't know how to use a smartphone"—the answer of 62% of the decision makers who do not use a smartphone, followed by "No need to use it," chosen by 22% of non-users. Some 11% thought smartphones are too expensive, and 6% do not use it for other reasons such as poor physical conditions (Table 4.6). The answers were similar between men and women. As for the findings based on age, non-users are mainly aged above 45. The 38% of non-users aged below 45 that do not use smartphones said that they found no need to do so. This share is higher than non-users aged above 45, which is 22%. On the other hand, the share answering "Don't know how to use a smartphone" increases as the age increases. Of those aged below 45, 38% do not use a smartphone because they don't know how. This share jumps to 53% for non-users aged 46–60, and 68% for those above 60. The findings based on different education levels is that as the years of schooling increases, the share of answering "Don't know how" decreases, from 68% for elementary school or below, to 54% for junior middle school, and 41% for high school or higher. The share

of answering "No need to use it" increases from 18% for elementary school or below, to 24% for junior middle school, and 43% for high school or higher.

Table 4.6: Reasons of Decision Makers of Agricultural Production and Sales for Not Using Smartphones, 2016

Description	Number of Observations	Do not Know How to Use Smartphone(%)	No Need to Use Smartphone(%)	Smartphone is Expensive (%)	Others (%)
Total	**679**	**62**	**22**	**11**	**6**
By gender					
Male	484	62	22	10	6
Female	195	60	22	13	6
By age					
16–30	1	0	0	100	0
31–45	21	38	38	24	0
46–60	258	53	22	16	8
Above 60	399	68	21	6	5
By education					
Elementary school or lower	420	68	18	11	3
Junior middle school	203	54	24	11	10
High school or higher	56	41	43	5	11

Source: Authors' compilation based on data from the first-round survey on e-commerce of the China Center for Agricultural Policy.

In February 2017, this survey also examined the reason why decisionmakers do not sell their products through e-commerce. "Time consuming" (49%) and "Don't know how to use it" (45%) are the major reasons (Table 4.7). Other reasons such as difficulties in in transporting and earning money account for 6%. The answers are quite different by gender. More than half of the men do not use e-commerce because they do not know how to use it, compared to only 22% of women decision makers. However, 67% of women decision makers think e-commerce is a waste of time, about 25% higher than men decision makers. One explanation is that women spend more time in caring for their children or grandchildren.

Table 4.7: Reasons for Not Using E-Commerce by Decision Makers of Agricultural Production and Sales, 2017

Description	Number of Observations	Do Not Know How to Use (%)	Time- Consuming (%)	Others[a] (%)
Total	**66**	**45**	**49**	**6**
By gender				
Male	48	54	42	4
Female	18	22	67	11
By age				
16–30	3	0	100	0
31–45	15	20	53	27
46–60	27	41	59	0
Above 60	21	76	24	0
By education				
Elementary school or lower	23	65	31	4
Junior middle school	24	42	50	8
High school or higher	19	27	68	5

[a] Other reasons given were difficulties in transporting and earning money.
Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

The most popular function of smartphones is social networking, as reported by 84% of respondents. Following this is the use of smartphones for news (68%), watching videos (67%), and other entertainment (64%). Around half of the smartphone users use it for shopping (49%) and making payments (52%). Only 5% sell products and services on smartphones (Table 4.8). These data show that smartphones have become an important channel for information acquisition and transactions, and still have room for these applications.

Table 4.8: Reasons for Using Smartphones, 2016 (%)

Description	Social	News	Shopping	Sales	Entertainment	Video	Learning	Payment
Total	**84**	**69**	**50**	**5**	**64**	**68**	**21**	**52**
By gender								
Male	84	71	46	5	64	67	22	50
Female	86	66	54	6	64	69	21	55
By age								
16–30	92	74	73	6	81	82	34	73
31–45	88	73	54	7	69	72	19	57
46–60	75	60	14	2	36	47	9	20
Above 60	37	34	2	1	18	23	4	6
By education								
Elementary school or lower	70	51	21	1	46	45	7	26
Junior middle school	85	69	46	5	62	69	17	48
High school or higher	92	77	69	8	75	78	35	71
Decision maker on agriculture?								
Yes	73	64	15	3	39	48	10	23
No	88	70	60	6	72	74	25	61

Source: Authors' compilation based on data from the first-round survey on e-commerce of the China Center for Agricultural Policy.

The purpose of using smartphones varies among different groups of people. Men and women use smartphones in similar ways except for some differences in news and shopping. More men use smartphones to browse the news while more women do shopping using a smartphone. The differences are more apparent among different age groups. The share of users of every function listed in the survey declines as the age increases. For example, 92% of the people aged 16–30 use smartphones for social networking, while 88% of the people aged 31–45 do so. This share declines to 75% for people aged 46–60 and drops to 37% for people above 60 years old. The sharpest drop occurs in shopping and payment. While 73% people aged 16 to 30 do shopping with a smartphone, only 2% percent of the people aged above 60 do so. The share of people who use smartphones to make payments is 73% among people aged 16 to 30, and only 6% among people aged above 60.

Educational attainment is another factor in which the use of smartphones varies. As years of schooling increase, the use of all eight functions increase as well. The use of smartphones by decision makers is different from other family members. Of all eight functions listed in Table 4.8, the share of decision makers using them is constantly lower than other family members. Except for sales and news, the gap between decision makers and other family members exceed 10% in all other six functions. The largest gap exists in shopping. Only 15% of the decision makers shop with their smartphones, while 60% of other family members do. This huge difference is mainly due to the age disparity between decisionmakers on agriculture and other family members.

In addition to smartphones, this survey also investigated other access to the internet of decision makers. In all of the 1,273 households surveyed, 411 respondents have heard of the internet and have used it. Among them, 385 accessed the internet through smartphones, 124 through desktop computers, 21 through laptops, and 4 through other devices. Smartphones are mainly used to access internet for social networking (90%) and reading the news (81%), followed by entertainment (60%). The order is reversed for respondents who used desktop computers. Desktop computer users access the internet primarily for entertainment (72%), reading the news (65%), and social networking (32%). Laptop users access the internet on their device for entertainment (86%), social networking (71%), and reading the news (76%).

Table 4.9: Internet Use by Type of Device, 2016

					Purchasing Products and Services		Acquiring Information on Production and/or Sales of Products	
Devices	Number of Observations	Entertainment (%)	Social (%)	News (%)	Agriculture (%)	NonAgriculture (%)	Agriculture (%)	NonAgriculture (%)
Respondents								
Smartphones	395	60	90	81	6	18	24	14
Desktops	124	72	32	65	11	22	24	19
Laptops	21	86	71	76	10	48	10	24
Others	4	75	25	50	0	0	25	0
Total	**411**	**64**	**87**	**81**	**7**	**19**	**26**	**15**
Other family members								
Smartphones	61	84	93	59	30	56	26	15
Desktops	21	76	67	67	29	62	52	24
Laptops	16	81	63	50	44	88	13	0
Total	**64**	**84**	**92**	**59**	**34**	**55**	**27**	**16**

Source: Authors' compilation based on data from the first-round survey on e-commerce of the China Center for Agricultural Policy.

Of note is that 26% of internet users acquire information on agricultural production and sales. Some 19% use the internet to buy nonagricultural products or services, 15% learn information about nonagricultural production and sales, and 7% bought agricultural products or services online. This means that among all 1,273 households nearly 10% are using the internet for transactions or production-related information. This shows great potential for ICT to penetrate into rural areas and the production and sales of agricultural products and services.

The survey team also asked about the access to and use of the internet by family members who had purchased agricultural products or services online and found 64 individuals who have done this. The main devices they use for internet access are smartphones. These people use the internet more frequently for entertainment and social networking than other respondents, and less for reading the news. One big difference between these people and respondents exists in online shopping: 34% of them listed shopping for agricultural products and services among the major uses of the internet, while only 7% of the respondents did so. More family members (55%) listed purchasing nonagricultural products and services than respondents (19%). These two groups of people do not differ much in information acquisition through the internet. This reflects the important role of the internet in information acquisition by rural people in the PRC—roughly a quarter use the internet to gather information on agricultural production and marketing, and less than a fifth do so for nonagricultural production and marketing.

To further explore the role of the internet in information acquisition on agricultural production and marketing, respondents were asked about their internet use in these areas. Among the 1,273 respondents, 5% use the internet to acquire information on agricultural production and 9% on agricultural marketing (Table 4.9). Men use the internet slightly more than women. The share of using internet to acquire information on agricultural production declines as age increases. The share is 19% for people aged 16–30, 11% for people aged 31–45, 7% for people aged 46–60, and 1% for people aged above 60. As for agricultural marketing, although the share of using the internet to acquire information declines as age increases in general, it peaks at ages 31 to 45. The share of using the internet for information acquisition monotonically increases with years of schooling, both for production and for marketing. Although negligible in people with 6 years of schooling or less (elementary school), the shares for people with a high school or higher education are almost double those for people with junior-middle-school education. Decision makers are different from those who are not only in acquiring information on marketing, with a small margin. Simple tabulations show that the information they care the most about is prices, either of agricultural products or of agricultural inputs.

4.4. The Use of Information and Communication Technologies by Different Village Conditions

In addition to analyzing the access to and use of ICTs at the individual level, the survey also looked at their relations with the conditions at the village level (such as infrastructure). However, as shown in Table 4.10, the results did not indicate very significant differences among different groups. This was because the major differences between users and non-users of phones are from the characteristics of farmers and households, or the weak correlations between village conditions and the use of phones, or due to the relatively high penetration rate of phones.

Table 4.10: Share of Respondents Acquiring Information on Agricultural Production and Marketing

Description	Number of Observations	Production (%)	Marketing (%)
Total	**1,273**	**5**	**9**
By gender			
Male	957	5	10
Female	316	4	6
By age			
16–30	16	19	19
31–45	176	11	23
46–60	553	7	12
Above 60	528	1	1
By education			
Elementary school	580	1	1
Junior middle school	507	7	13
High school or higher	186	12	25
Decision maker on agriculture?			
Yes	1,004	5	10
No	269	5	8

Source: Authors' compilation based on data from the first-round survey on e-commerce of the China Center for Agricultural Policy.

The minor differences among groups may also provide an interesting insight into the impacts of village infrastructure on farmers' uses of phones to some extent. For example, it seems that there is a relatively high number of farmers using phones if the village has a CMCC or Unicom business office. Particularly, for the decision makers, who have both higher proportions of using mobile and smartphones if they are in a village with a CMCC or Unicom business office, the distance to the nearest national road seems positively correlated with the use of phones, suggesting the necessity of mobile phones for farmers in relatively remote regions (Table 4.11). On the contrary, due to the substitution of mobile phones for smartphones, there are fewer farmers who use smartphones who are located in remote regions (Table 4.12). The univariate comparison suggests that although the conditions and infrastructures of village are not the major factors determining farmers' decision to use phones, they do play a secondary role.

Table 4.11: Share of Mobile Phone Owners by Village Conditions, 2016

	All Members			Decision Makers		
Categories	Number of Observations	Mobile (%)	Smart (%)	Number of Observations	Mobile (%)	Smart (%)
With a package distribution or collection point						
No	3,548	89	71	1,134	92	47
Yes	1,296	89	71	379	89	48
Distance to the nearest package distribution or collection point						
Within 1 km	1,296	89	71	379	89	48
<3 km	1,090	87	71	350	92	48
3–5 km	1,147	91	71	349	94	45
>=5 km	1,311	88	71	435	91	47
With a post office						
No	4,106	89	71	1,293	92	47
Yes	738	90	73	220	90	50
Distance to the nearest post office						
Within 1 km	738	90	73	220	90	50
<3 km	1,334	88	72	417	90	47
3–5 km	1,368	89	68	442	93	43
>=5 km	1,404	89	72	434	92	43
Year the post office was established						
<=2000	221	87	73	66	86	58
2000–2012	191	87	77	63	90	61
>2012	321	93	73	89	91	41
Without a post office	4,111	89	71	1,295	92	46

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Table 4.11 *continued*

Categories	All Members			Decision Makers		
	Number of Observations	Mobile (%)	Smart (%)	Number of Observations	Mobile (%)	Smart (%)
With a CMCC or Unicom business office						
No	3,605	88	71	1,122	91	46
Yes	1,239	91	71	391	93	50
Distance to the nearest CMCC or Unicom business office						
Within 1 km	1,239	91	71	391	93	50
<=2 km	1,311	89	73	404	91	50
2–4 km	1,119	89	70	350	92	45
>4 km	1,175	87	71	368	90	44
Year CMCC or Unicom business office was established						
<=2007	473	89	72	149	91	53
2007–2011	369	91	72	120	93	52
>2011	397	93	69	122	97	44
No CMCC or Unicom office	3,605	88	71	1,122	91	46
Initial year of mobile phone services						
<=1995	1,891	89	71	598	93	47
1995–2000	2,139	89	72	659	91	50
>2000	814	87	69	256	91	41
Initial year of broadband internet access						
<=2005	1,712	89	71	527	91	49
2005–2010	1,703	89	70	533	93	48
>2010	1,429	88	73	453	91	45
Distance to the nearest national highway						
<3 km	1,466	87	72	488	89	49
3–10 km	1,664	89	72	513	92	49
>=10 km	1,714	90	71	512	94	43
Distance to township						
<=2.5 km	1,640	88	73	510	91	52
2.5–5.0 km	1,578	89	69	491	92	41
>5.0 km	1,626	89	71	512	92	48
Distance to county						
<=12.5 km	1,801	89	72	558	91	50
12.5–25.0 km	1,616	89	70	500	91	42
>25.0 km	1,427	90	71	455	93	48

CMCC = China Mobile, km = kilometer, Unicom = China Unicom.

Source: Authors' compilation based on data from the first-round survey on e-commerce of the China Center for Agricultural Policy.

Table 4.12: Share of Smartphone Owners by Village Conditions, 2016

Categories	All Members		Decision Makers	
	Number of Observations	Smartphone Owners (%)	Number of Observations	Smartphone Owners (%)
With a post office				
No	882	64	841	62
Yes	194	66	180	64
Distance to the nearest post office				
Within 1 km	194	66	180	64
<3 km	209	67	205	67
3–5 km	382	63	358	60
>=5 km	291	63	278	62
With a CMCC or Unicom business office				
No	1076	64	1021	63
Yes	0	n.a	0	n.a
Distance to the nearest CMCC or Unicom business office				
Within 1 km	0	n.a	0	n.a
<=2 km	120	69	113	67
2–4 km	335	62	312	59
>4 km	621	65	596	64
Initial year of mobile phone services				
<=1995	352	62	330	60
1995–2000	349	66	338	65
>2000	375	65	353	63
Initial year of broadband internet access				
<=2005	491	65	467	63
2005–2010	388	63	367	61
>2010	197	66	187	65
Distance to the nearest township road or higher-level road				
<3 km	966	65	919	63
3–10 km	72	58	64	53
>=10 km	38	74	38	74
Distance to the township				
<=2.5 km	277	68	264	67
2.5–5.0 km	388	64	370	62
>5.0 km	411	63	387	60

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Table 4.12 *continued*

Categories	All Members		Decision Makers	
	Number of Observations	Smartphone Owners (%)	Number of Observations	Smartphone Owners (%)
Distance to county				
<=12.5 km	255	61	242	59
12.5–25.0 km	211	66	207	65
>25.0 km	610	65	572	63

CMCC = China Mobile, km = kilometer, Unicom = China Unicom.
Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

Table 4.13 summarizes the uses of smartphones by the conditions and infrastructure existing in the villages. Interestingly, although there is a significantly higher proportion of shopping using smartphones if the village has an express delivery point, the distance to the nearest express delivery point is not correlated to the proportion of shopping using smartphones. Also, farmers are more likely to shop with their smartphones if they are located in a village that has or is near a post office. It is interesting to note that if the post office or the CMCC or Unicom business office was established earlier, the proportion of smartphone users who shop online is lower. This implies that the recent expansion of post offices, and CMCC or Unicom business offices, is likely to encourage farmers to go shop using their smartphones; and that developing ICT infrastructure is essential in promoting the development of e-commerce.

Table 4.13: Purpose for Using Smartphones by Village Condition, 2016

Description	Social	News	Shopping	Sales	Entertainment	Video	Learning	Payment
With a package distribution/collection point								
No	84	67	47	5	63	66	20	50
Yes	86	74	56	7	66	72	25	58
Distance to the nearest package distribution or collection point								
Within 1 km	86	74	56	7	66	72	25	58
<3 km	88	74	47	5	64	71	19	52
3–5 km	80	63	47	5	61	67	20	49
>=5 km	84	65	47	5	64	62	22	49
With a post office								
No	84	68	49	5	64	68	21	51
Yes	86	71	54	5	63	69	22	57
Distance to the nearest post office								
Within 1 km	86	71	54	5	63	69	22	57
<3 km	88	73	53	7	67	71	21	57
3–5 km	81	65	47	5	60	65	20	49
>=5 km	83	66	47	5	65	67	22	49

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Table 4.13 *continued*

Description	Social	News	Shopping	Sales	Entertainment	Video	Learning	Payment
Year post office established								
<=2000	87	68	48	0	63	65	18	50
2000–2012	86	67	50	8	57	62	18	56
>2012	84	72	59	6	69	73	25	58
No post office	84	69	49	5	64	68	22	52
With a CMCC or Unicom business office								
No	84	69	50	6	66	68	21	53
Yes	85	69	48	4	58	66	22	52
Distance to the nearest CMCC or Unicom business office								
Within 1 km	85	69	48	4	58	66	22	52
<=2 km	87	73	55	8	69	74	22	57
2–4 km	82	68	47	5	63	67	19	50
>4 km	83	64	47	4	66	63	22	50
Year a CMCC or Unicom business office was established in area								
<=2007	83	67	43	1	56	64	19	44
2007–2011	86	71	46	3	58	66	24	54
>2011	86	70	58	8	62	69	25	58
Without one	84	69	50	6	66	68	21	53
Initial year of mobile phone services								
<=1995	86	70	51	6	63	66	22	53
1995–2000	84	68	50	4	64	69	22	52
>2000	83	68	46	6	67	70	19	51
Initial year of broadband internet access								
<=2005	85	72	54	7	63	67	24	56
2005–2010	84	68	49	4	64	69	22	53
>2010	85	66	45	5	65	68	18	47
Distance to the nearest national highway								
<3 km	83	68	47	6	66	67	17	51
3–10 km	85	69	50	7	61	67	25	52
>=10 km	85	70	51	4	65	70	21	53
Distance to township								
<=2.5 km	85	72	49	5	62	69	22	54
2.5–50 km	84	67	49	5	65	68	20	50
>5 km	85	67	50	6	66	66	22	53
Distance to county								
<=12.5 km	83	70	52	6	64	67	24	55
12.5–25.0 km	87	70	48	4	63	69	21	51
>25 km	83	66	49	6	65	67	19	50

CMCC = China Mobile, km = kilometer, Unicom = China Unicom.
Source: Authors' compilation based on data from the first-round survey on e-commerce of the China Center for Agricultural Policy.

Tables 4.14 and 4.15 further report the decision makers' reasons for not using smartphones and e-commerce based on village conditions. If the village has an express delivery point, those who responded that there is "No need to use it" is 18%, which is lower than the proportion of respondents located in villages without an express delivery point (Table 4.14). This result implies that the availability of an express delivery point in the village can reduce farmers' perceptions on the necessity of using smartphones. The existence of post offices in villages can improve farmers' views of the necessity of using smartphone. In terms of the distance variables including "distance to the nearest post office," "distance to the nearest CMCC or Unicom business office," "distance to the nearest national road," "distance to township," and "distance to county," farmers seem to have a relatively high proportion of perceiving the usefulness of smartphones if they are located in a remote village far from any post office and CMCC or Unicom business office. Fewer farmers living in villages near the national road or where CMCC or Unicom business office have been established earlier also responded that they "Don't know how to use smartphone." A high proportion of farmers located near national roads, townships, and counties think smartphones are too expensive.

Table 4.14: Reasons of Decision Makers on Agricultural Production and Sales for Not Using Smartphones by Village Conditions, 2016

Categories	Number of Observations	Don't Know How to Use (%)	No Need to Use(%)	Smartphone Is Expensive (%)	Others (%)
With a package distribution or collection point					
No	516	61	23	12	4
Yes	167	63	18	8	11
Distance to the nearest package distribution or collection point					
Within 1 km	167	63	18	8	11
<3 km	155	64	22	12	3
3–5 km	169	57	26	11	6
>=5 km	192	61	22	12	4
With a post office					
No	587	61	23	11	5
Yes	96	64	19	9	8
Distance to the nearest post office					
Within 1 km	96	64	19	9	8
<3 km	185	63	22	12	3
3–5 km	215	64	21	9	6
>=5 km	187	55	26	12	7
Year the post office was established					
<=2000	23	48	26	17	9
2000–2012	21	62	19	5	14
>2012	47	74	17	2	6
No post office	592	61	22	11	5

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Table 4.14 *continued*

Categories	Number of Observations	Don't Know How to Use (%)	No Need to Use(%)	Smartphone Is Expensive (%)	Others (%)
With a CMCC or Unicom business office					
No	515	61	22	12	5
Yes	168	61	23	8	8
Distance to the nearest CMCC or Unicom business office					
Within 1 km	168	61	23	8	8
<=2 km	173	68	16	13	3
2–4 km	167	61	24	10	5
>4 km	175	55	26	13	6
Year the CMCC or Unicom business office was established					
<=2007	59	49	31	8	12
2007–2011	52	60	21	13	6
>2011	57	74	16	4	7
No CMCC or Unicom office	515	61	22	12	5
Initial year of mobile phone services					
<=1995	268	65	21	8	6
1995–2000	286	58	23	12	6
>2000	129	60	21	14	5
Initial year of broadband internet access					
<=2005	232	66	21	8	5
2005–2010	243	54	27	10	9
>2010	208	63	17	15	4
Distance to the nearest national highway					
<3 km	212	57	22	15	7
3–10 km	219	61	22	9	8
>=10 km	252	65	23	9	4
Distance to township					
<=2.5 km	215	64	15	15	6
2.5–5.0 km	249	63	25	8	5
>5.0 km	219	57	26	11	7
Distance to county					
<=12.5 km	234	66	18	12	5
12.5–25.0 km	246	65	20	8	7
>25.0 km	203	51	30	13	6

CMCC = China Mobile, km = kilometer, Unicom = China Unicom..
Source: Authors' compilation based on data from the first-round survey on e-commerce of the China Center for Agricultural Policy.

Table 4.15: Reasons of Decision Makers on Agricultural Production and Sales for Not Using E-Commerce, 2016

Description	Number of Observations	Don't Know How to Use (%)	Time-consuming (%)	Others[a] (%)
Total	**66**	**44**	**50**	**6**
With a post office				
No	46	48	43	9
Yes	20	35	65	0
Distance to the nearest post office				
With one	20	35	65	0
<3 km	10	60	20	20
3–5 km	15	40	47	13
>=5 km	21	48	52	0
With a CMCC or Unicom business office				
No	66	44	50	6
Yes	0	n.a	n.a	n.a
Distance to the nearest CMCC or Unicom business office				
Within 1 km	0	n.a	n.a	n.a
<=2 km	11	64	18	18
2–4 km	9	22	56	22
>4 km	46	43	57	0
Initial year of mobile phone services				
<=1995	25	48	52	0
1995–2000	26	42	50	8
>2000	15	40	47	13
Initial year of broadband internet access				
<=2005	34	44	56	0
2005–2010	17	52	24	24
>2010	15	33	67	0
Distance to the nearest township road or higher-level road				
<3 km	60	43	50	7
3–10 km	0	n.a	n.a	n.a
>=10 km	6	50	50	0
Distance to township				
<=2.5 km	21	48	43	9
2.5–5.0 km	22	36	64	0
>5.0 km	23	48	43	9

continued on next page

Table 4.15 *continued*

Description	Number of Observations	Don't Know How to Use (%)	Time-consuming (%)	Others[a] (%)
Distance to county				
<=12.5 km	5	60	40	0
12.5–25.0 km	18	61	39	0
>25.0 km	43	35	60	5

CMCC = China Mobile, km = kilometer, Unicom = China Unicom..
a Other reasons refer to difficulties in transporting and earning money.
Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

The differences in the shares of farmers using computers among the groups by village conditions are presented in Table 4.16. The results show that in the villages with an express delivery point, post office, or CMCC or Unicom business office, significantly more farmers use computers, both desktop and laptops. Meanwhile, the distance to the express delivery point, post office, CMCC or Unicom business office seems negatively correlated with the share of farmers using computers. Also, recently established post offices or CMCC and Unicom business offices can better promote farmers' use of computers, compared with the earlier established post offices or CMCC or Unicom business offices. Hence, the provision of express delivery points, post offices, or CMCC or Unicom business offices in the village could further facilitate farmers' use of computers in rural areas of the PRC.

Table 4.16: Share of Farmers Using Desktop and Laptop by Village Conditions, 2016

Categories	Number of Observations	Computer Use (%)
With a package distribution or collection point		
No	935	41
Yes	338	54
Distance to the nearest package distribution or collection point		
Within 1 km	338	54
<3 km	295	48
3–5 km	290	43
>=5 km	350	34
With a post office		
No	1,082	43
Yes	191	54
Distance to the nearest post office		
Within 1 km	191	54
<3 km	358	51
3–5 km	360	42
>=5 km	364	36

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Table 4.16 *continued*

Categories	Number of Observations	Computer Use (%)
Year established of the post office		
<=2000	61	51
2000–2012	50	46
>2012	80	55
No post office	1,082	44
With a CMCC or Unicom business office		
No	952	43
Yes	321	51
Distance to the nearest CMCC or Unicom business office		
Within 1 km	321	51
<=2 km	351	55
2–4 km	301	43
>4 km	300	29
Year established of the CMCC or Unicom business office		
<=2007	120	48
2007–2011	100	50
>2011	101	56
No CMCC or Unicom office	952	43
Initial year of mobile phone services		
<=1995	513	49
1995–2000	550	49
>2000	210	26
Initial year of broadband internet access		
<=2005	468	55
2005–2010	435	47
>2010	370	29
Distance to the nearest national highway		
<3 km	393	41
3–10 km	427	46
>=10 km	453	47
Distance to township		
<=2.5 km	438	45
2.5–5.0 km	422	49
>5.0 km	413	41
Distance to county		
<=12.5 km	465	51
12.5–25.0 km	431	44
>25.0 km	377	38

CMCC = China Mobile, km = kilometer, Unicom = China Unicom.
Source: Authors' compilation based on data from the first-round survey on e-commerce of the China Center for Agricultural Policy.

The initial year of use of mobile phone services and internet access are also correlated with the farmers' use of computers. As shown in Table 4.16, in areas where mobile phone services or internet access were established earlier, the proportion of farmers using computers is higher. This result indicates that the establishment of ICT infrastructure and services are an important precondition for promoting farmers' uses of computers. Moreover, the distance to county is negatively associated with the share of farmers using computers, suggesting that the farmers located in remote regions are less likely to use computers. Thus, the promotion of the use of computer should be prioritized among farmers in remote regions.

Table 4.17 further compares the share of respondents who learn information on production and marketing through the internet among different groups. Unfortunately, due to the relatively low proportion of farmers learning production and marketing formation online, the differences among groups are insignificant. An exception is with regard to the status of CMCC and/or Unicom business offices. Respondents have a slightly higher proportion of learning production and marketing information through the internet in villages that have a CMCC and/or Unicom business office, or are near a CMCC and/or Unicom business office.

Table 4.17: Share of Respondents Learning Information on Production and Marketing through the Internet by Village Conditions, 2016

Categories	Observation	Production (%)	Marketing (%)
Total	**1,273**	**5**	**9**
With a package distribution or collection point			
No	935	5	10
Yes	338	5	9
Distance to the nearest package distribution or collection point			
Within 1 km	338	5	9
<3 km	295	5	9
3–5 km	290	6	9
>=5 km	350	5	10
With a post office			
No	1,082	5	9
Yes	191	3	11
Distance to the nearest post office			
Within 1 km	191	3	11
<3 km	358	6	8
3–5 km	360	7	9
>=5 km	364	4	10

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Table 4.17 *continued*

Categories	Observation	Production (%)	Marketing (%)
Year post office was established			
<=2000	61	3	5
2000–2012	50	2	18
>2012	80	1	10
Without 1 year	1,082	6	9
With a CMCC or Unicom business office			
No	952	5	8
Yes	321	6	14
Distance to the nearest CMCC or Unicom business office			
Within 1 km	321	6	14
<=2 km	351	6	9
2–4 km	301	5	7
>4 km	300	3	7
Year established of the CMCC or Unicom business office			
<=2007	120	4	13
2007–2011	100	7	13
>2011	101	6	16
Within 1 year	952	5	8
Initial year of mobile phone services			
<=1995	513	5	9
1995–2000	550	5	11
>2000	210	4	5
Initial year of broadband internet access			
<=2005	468	5	12
2005–2010	435	6	9
>2010	370	4	6
Distance to the nearest national highway			
<3 km	393	4	6
3–10 km	427	7	13
>=10 km	453	4	9
Distance to township			
<=2.5 km	438	7	9
2.5–5.0 km	422	4	8
>5 km	413	5	11
Distance to county			
<=12.5 km	465	6	9
12.5–25 km	431	5	10
>25 km	377	4	9

CMCC = China Mobile, km = kilometer, Unicom = China Unicom..
Source: Authors' compilation based on data from the first-round survey on e-commerce of the China Center for Agricultural Policy.

4.5. The Operation of E-Commerce in Selling Agricultural Products

Based on the data from the typical survey in Shandong and Zhejiang provinces, this subsection describes the operation of e-commerce in selling agricultural products by farmers, including apples, peaches, pecans, sweet potatoes, and kiwifruits. Results are presented in Tables 4.18 to 4.20. It is worth noting that the results presented here are based on the 250 household surveys from 20 villages in five counties, of which 100 households with e-commerce and 50 households without e-commerce are from e-commerce villages, and 100 households are from non-e-commerce villages but some households are also engaged in e-commerce. Therefore, there should be careful interpretation of the results presented in this subsection due to the nature of the sampling approach. The most useful information is the change over time and the difference in the percentage of products sold through e-commerce by different classes (grades) of the product.

Table 4.18 presents the percentages of online sales and its shares by different grades of apple. The results show that while there is not much difference in the percentage of online sales of apples (about 35%) from 2015 to 2017, there is large difference in the share of online sales by apple grade. Second-class apples have a higher share of online sales. However, in total, 67.2% of the online sales were for first-class apples despite only 33.1% of them were sold online in 2017 (Table 4.18).

Table 4.18: Percentage of Online Sales and Shares in Different Classes of Produce, 2015–2017

	Online Sales			Shares per Class		
Description	2015	2016	2017	2015	2016	2017
Apples	**35.4**	**35.8**	**35.4**	**100.0**	**100.0**	**100.0**
First class	33.5	33.9	33.1	67.6	68.1	67.2
Second class	43.2	43.4	43.5	32.3	31.8	32.7
Third class	2.3	3.2	3.6	0.1	0.1	0.1
Peaches	**13.5**	**32.7**	**37.4**	**100.0**	**100.0**	**100.0**
First class	10.9	39	48.9	32.6	54.2	64.1
Second class	13.4	26.2	24.8	34.7	24.9	21.7
Third class	20.7	32.2	32.8	32.7	20.9	14.2
Pecans	**66.4**	**67.6**	**61.4**	**100.0**	**100.0**	**100.0**
Highly processed pecans	86.2	85.8	76.3	51.8	50.5	44.1
Processed pecans	55.6	59.3	55.5	47.9	49.5	55.9
Roughly processed pecans	8.0	0	0	0.3	0	0
Kiwifruits	**50.7**	**50.1**	**46.4**	**100.0**	**100.0**	**100.0**
First class	47.8	47.3	44.9	49.1	57	56.9
Second class	59.0	56.0	54.9	33.6	30.9	31.1
Third class	54.2	52.6	46.1	15.6	10.6	10.3
Fourth class	0	0	0.3	0	0	0.02

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Table 4.18 *continued*

Description	Online Sales			Shares per Class		
	2015	2016	2017	2015	2016	2017
Red kiwifruit	**0**	**63.1**	**39.1**	**1.8**	**1.5**	**1.7**
Sweet potatoes	**31.4**	**44.1**	**50.5**	**100.0**	**100.0**	**100.0**
First class	32.3	43.4	49.1	82.4	78.5	72.6
Second class	33.5	46.7	56.1	16	15.9	21.4
Third class	10.5	46	49.3	1.6	5.5	5.9
Dried sweet potatoes	**0**	**100.0**	**100.0**	**0**	**0.1**	**0.1**

Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

Peaches are also among the major products sold online in the study areas. The percentage of online sales of peaches increased from 13.5% in 2015 to 37.4% in 2017, and although first-class peaches accounted for the most online sales in 2016 and 2017, less than 50% of them were sold online. As for pecans, 61.4% of those produced were sold online in 2017; 44.1% of online sales were of the highly processed type, which accounts for 76.3% of highly processed pecans sold.

The percentage of online sales of kiwifruits decreased slightly from 50.7% in 2015 to 46.4% in 2017. This is because the total output of kiwifruits increased rapidly in the surveyed villages. The percentage of online sales of sweet potatoes increased from 31.4% in 2015 to 50.5% in 2017, and more than 70% of them were of the first-class type.

Table 4.19 shows the percentage of online sales and number of platforms used in online sales for the commodities surveyed in the sample villages. In general, the percentages of online sales increased significantly over time, rising from 9.9% in 2013 to 45.0% in 2017. However, the structure on the number of e-commercial platforms used by farmers did not change. Nearly two-thirds of the respondents used one platform while about a third used two.

Table 4.19: Percentage of Online Sales and the Platforms Used, 2013-2017

Year	Share of Online Sales	Online Sales		
		One Platform	Two Platforms	Three Platforms
2013	9.9	65	33	2
2014	18.3	62	36	3
2015	25.0	62	35	3
2016	37.5	64	34	2
2017	45.0	65	32	3

Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

Table 4.20 presents the main platforms that are used for selling agricultural products through the internet. The professional websites are Taobao, Jingdong, etc., in which the sellers need to invest in building online stores. With the popularity of the social network WeChat, some sellers use the app's moments function to post their products because it is free, even though they can only sell their products to their contacts within the app's network of sellers. Table 4.20 shows that more farmers use WeChat over professional websites to sell their products.

Table 4.20: Percentage of Online Sales and the Types of Platforms Used, 2013–2017

		Among Online Sales		
Year	Share of Online Sales	Only Use Professional Websites	Only Use WeChat	Use Both Professional Websites and WeChat
2013	9.9	30	39	30
2014	18.3	15	51	34
2015	25.0	13	53	34
2016	37.5	9	58	33
2017	45.0	12	58	30

Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center Agricultural Policy.

Chapter 5

Uses of Information and Communication Technologies in Agriculture and E-Commerce Based on Survey Data

5.1. Marketing Products

Table 5.1 presents the marketing of products by 1,273 rural households and their willingness to sell online in 2016. The products surveyed included grain, cash crops, vegetables, fruit, animal products, and others. Among rural households surveyed, 45% sold their grain. Fruit (11%) and animal (12%) were the second most agricultural products that were sold by rural households. These were followed by other cash crops (9%) and vegetables (8%). For this national representative sample, there were barely households that had sold their products online by 2016. In total, there was only about 2% of household that sold their products online.

Table 5.1: Percentages of Rural Households Selling Their Products and Their Attitudes Toward Operating E-Commerce, 2016 *(%)*

Products	Sells Product	Sells Product Online	Willing to Sell Their Product Online	Unwilling to Sell Their Product Online
Grain	45.0	0.0	11.0	34.0
Fruit	11.0	0.8	4.4	6.3
Vegetables	9.0	0.1	2.0	7.0
Other crops	9.0	0.0	2.0	7.0
Animal	12.0	0.0	3.0	9.0
Others	7.0	0.0	2.0	5.0

Source: Authors' compilation based on data from the first-round survey on e-commerce of the China Center for Agricultural Policy.

However, there are a large number of rural households that are willing to sell their products online. For example, among those selling grain, 24% (11/45) of them said they are willing to sell their products online (Table 5.1). The percentage is even higher for those selling fruits (about 40%), while those selling other produce range from 22% to 29%.

Table 5.2 presents the reasons for their willingness to sell online by commodity. Those who are willing to sell online said that this is mainly because they believe they could sell their products at higher prices online and because they think selling online is more convenient. There are also some farmers, particularly those who produce and sell vegetables, who believe that they can find more buyers online.

Table 5.2: Reasons for Being Willing to Operate E-Commerce by Agricultural Products, 2016

Crops	Number of Observations	Responses		
		Convenience (%)	More Buyers (%)	Higher Prices (%)
Grain	143	45	7	48
Fruit	51	35	6	59
Vegetables	29	45	34	21
Other crops	23	57	9	35
Animal	38	37	18	45
Others	24	42	17	42

Source: Authors' compilation based on data from the first-round survey on e-commerce of the China Center for Agricultural Policy.

Table 5.3 presents the respondents' reasons for being unwilling to sell online in 2016. The main reason for most households was their lack of knowledge and skills with respect to agricultural products, followed by a perception that online selling is inconvenient, and the lack of trust in online transactions.

Table 5.3: Reasons for Being Unwilling to Operate E-Commerce by Agricultural Products, 2016

Products	Number of Observations	Responses					
		Lack of Knowledge and Skills (%)	Inconvenience (%)	Poor Trust (%)	No Need (%)	Lower Prices (%)	Poor Storage and Transportation Conditions (%)
Grain	428	41	18	17	12	5	1
Cash crops	88	47	17	14	12	2	0
Vegetables	83	52	8	17	7	7	4
Fruit	80	41	13	16	8	8	4
Animal	111	45	21	13	11	4	0
Others	60	60	13	11	3	5	5

Source: Authors' compilation based on data from the first-round survey on e-commerce of the China Center for Agricultural Policy.

5.2. Purchasing Agricultural Inputs

Table 5.4 presents the attitude toward purchasing agricultural inputs by 1,273 rural households in 2016, including seeds, pesticides, herbicides, fertilizers, agricultural machinery, veterinary medicine, feeds, and others. Of the respondent households, 84.0% bought fertilizer, but only 0.1% of households bought fertilizers online. Similarly, over 80.0% of the households bought pesticides, herbicides, and seeds, but less than 0.5% bought online. Around 20.0% of households purchased agricultural

machinery, veterinary medicine, and feeds, but only around 0.2% shopped online. Of the respondent households that bought agricultural inputs not from online sources, less than 15% of the households were willing to buy seeds, pesticides, herbicides, and fertilizers online, while around 70% were not. Only 3% of the households surveyed were willing to buy agricultural machinery, veterinary medicine, and feeds online, and more than 10% were not.

Table 5.4: Attitudes Toward Purchasing Agricultural Inputs by Households, 2016 (%)

Inputs	Bought the Product	Bought Online	Willing to Buy Online	Unwilling to Buy Online
Seed	79.0	0.2	12	66
Pesticide	83.0	0.2	14	69
Herbicide	79.0	0.3	13	66
Fertilizer	84.0	0.1	14	70
Agricultural machinery	15.0	0.2	3	11
Veterinary medicine	14.0	0.2	3	10
Feed	17.0	0.1	3	14

Note: The total sample is 1,273 households.
Source: Authors' compilation based on data from the first-round survey on e-commerce of the China Center for Agricultural Policy.

Table 5.5 presents the reasons for the households' willingness to buy agricultural inputs online according to the 2016 survey, the most common of which is convenience. The second most significant reason is the lower prices online, while the rest of the households are willing to buy agricultural inputs online because of product diversity and better quality.

Table 5.5: Reasons for Being Willing to Buy Agricultural Inputs Online, 2016 (%)

		Responses			
Inputs	Number of Observations	Convenience (%)	Lower Prices (%)	Product Diversity (%)	Better Quality (%)
Seed	151	46	41	8	5
Pesticide	172	47	41	7	5
Herbicide	168	47	42	7	4
Fertilizer	172	47	42	8	3
Agricultural machinery	43	49	40	12	0
Veterinary medicine	37	54	38	8	0
Feed	36	56	33	11	0

Source: Authors' compilation based on data from the first-round survey on e-commerce of the China Center for Agricultural Policy.

Table 5.6 presents the reasons that households were willing or unwilling to buy agricultural inputs online. Most households said that they lacked the necessary knowledge and skills to buy products online while many did not trust online transactions. Some households felt that buying products online meant they would have little control over quality, while others thought online shopping was inconvenient. A small percentage of the surveyed households believed that there was no need to buy online or agricultural inputs cost higher if bought online.

Table 5.6: Reasons for Being Unwilling to Buy Agricultural Inputs Online, 2016

		Responses					
Input	Number of Observations	Lack of Knowledge and Skills (%)	Poor Trust (%)	Weak Control over Quality (%)	Inconvenience (%)	No Need (%)	Higher Prices (%)
Seed	846	38	21	16	14	7	1
Pesticide	877	40	20	15	14	8	1
Herbicide	835	39	20	14	14	8	1
Fertilizer	894	40	20	15	13	8	1
Agricultural machinery	145	36	21	15	14	9	1
Veterinary medicine	133	44	18	14	14	8	1
Feed	178	39	22	12	18	6	1
Others	8	75	0	13	13	0	0

Source: Authors' compilation based on data from the first-round survey on e-commerce of the China Center for Agricultural Policy.

5.3. Custom Services Related to Agricultural Production

The survey found that about half of the respondent households bought custom services for their agricultural production in 2016, although none of them bought these services through the internet. Table 5.7 presents the willingness of farmers to buy custom services in agricultural production online. In general, more than 78% of rural households were not willing to buy custom services for their agricultural production online in 2016. This is especially true for ploughing, seeding, spraying pesticides, irrigating, weeding, harvesting and others, where more than 80% of the rural households surveyed said that they are not willing to buy custom services for their agricultural production over the internet.

Table 5.7: Willingness to Buy Custom Services over the Internet for Agricultural Production, 2016 *(%)*

Services	Yes	No	No Idea	Total
Ploughing	13	84	2	100
Seeding	13	83	4	100
Growing seedlings	14	79	7	100
Fertilizing	20	78	2	100
Spraying pesticides	10	88	3	100
Irrigating	0	100	0	100
Weeding	19	81	0	100
Harvesting	15	82	3	100
Others	10	90	0	100
Total	14	83	3	100

Note: Percentages may not total 100% because of rounding.
Source: Authors' compilation based on data from the first-round survey on e-commerce of the China Center for Agricultural Policy.

Most of the respondents who said they were willing to buy custom services in agricultural production over the internet said that buying online is more convenient, while others said the prices are lower. Those who indicated that they are unwilling to buy custom services for the agricultural production online expressed anxiety about scams, and were concerned about product quality and price.

The findings on the willingness of respondents to transact online across different villages suggest that better ICT infrastructure is positively associated with the willingness to transact online. For example, households that have had broadband internet access earlier are more willing to transact online. Among households whose villages had acquired broadband internet access after 2010, the share of those willing to sell online is 11%, higher than those who had access earlier. This again suggests that the more recent development of ICT infrastructure has larger impacts on the willingness to undertake online transactions.

Chapter 6

Major Factors Affecting Applications of Information and Communication Technology in Agriculture

This chapter explores the factors that may affect the adoption of e-commerce by farmers based on data from the case study survey in Shandong and Zhejiang provinces.

6.1. Major Factors at Village Level

Table 6.1 presents the differences in village conditions between villages that operate e-commerce enterprises and those that do not. The results show that the e-commercial villages are slightly closer to the local townships and counties than the non-e-commercial villages. The distance of e-commercial villages to the nearest farmers' market, road, and other e-commercial villages are shorter than that for non-e-commercial villages. Mobile phone services and broadband internet access were established earlier in e-commercial villages. More e-commercial villages have post offices, online shopping stores, and local mail carrier and/or courier.

Table 6.1: Differences in Village Conditions between E-Commercial and Non-E-Commercial Villages

Description	E-Commercial Villages	Non-E-Commercial Villages
Distance to local township (km)	7.4	7.5
Distance to local county (km)	35.9	39.2
Distance to the nearest farmers' market (km)	4.7	10.7
Distance to the nearest road (km)	0.4	2.5
Distance to the nearest e-commercial village	4.3	8.2
Initial year of mobile phone services	1998	2001
Initial year of broadband internet access	2005	2009
With post office (yes=1, otherwise =0)	0.2	0.1
With online shopping store (yes=1, otherwise =0)	0.4	0.2
With local postal worker or delivery worker (yes=1, otherwise =0)	0.8	0.6
With local company (yes=1, otherwise =0)	0.5	0.4

km = kilometer.
Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

6.2. Major Factors at Household Level

Table 6.2 compares household conditions of those with and without online sales. In the sample, 59% of households interviewed in 2018 experienced online sales, and the remaining 41% did not . Among 250 households, 224 households are less than 2 km away from their village committees, and 60% of them had online sales. Out of the 250 households, 10 households are more than 5 km away from their village committees, and only 30% of them had online sales. This suggests that households have a higher possibility to adopt online sales if they are closer to their village committees. The distance of the households to townships, counties, the nearest motor roads, package distribution and/or collection points, and neighbors also matter. If the services of a courier picking up goods from the home were available, the percentage of households that would be selling online would be higher. Households that sell online have more relatives who sell agricultural products through the internet. Most of the households do not have e-commerce subsidies, and only 13 households who have had online sales have been subsidized.

Table 6.2: Comparing Household Conditions between Households With and Without Online Sales

Description	Number of Observations	With Online Sales (%)	Without Online Sales (%)
Total	**250**	**59**	**41**
Distance to village committee			
<=2 km	224	60	40
2–5 km	16	63	38
>5 km	10	30	70
Distance to township			
<=5 km	157	64	36
5–10 km	44	55	45
>10 km	49	45	55
Distance to county			
<=25 km	113	63	37
25–60 km	99	63	37
>60 km	38	37	63
Distance to the nearest motor road			
<=1 km	222	58	42
1–10 km	26	65	35
>10 km	2	100	0
Distance to the nearest neighbor			
<=20 m	240	59	41
>20 m	10	50	50

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Table 6.2 *continued*

Description	Number of Observations	With Online Sales (%)	Without Online Sales (%)
Distance to the nearest package distribution or collection point			
<=2 km	109	65	35
2–10 km	128	52	48
>10 km	13	77	23
Distance to the nearest CMCC or Unicom business			
<=5 km	173	64	36
5–15 km	56	43	57
>15 km	21	57	43
Can the courier pick up from home?			
Yes	119	78	22
No	131	41	59
With internet access?			
Yes	217	63	37
No	33	30	70
With 2G/3G/4G network?			
Yes	226	62	38
No	24	25	75
With computer?			
Yes	198	66	34
No	52	31	69
Initial year to buy the first computer			
<=2005	28	89	11
2006–2010	83	71	29
2011–2015	81	52	48
>2015	6	83	17
With online shopping experiences?			
Yes	168	77	23
No	82	22	78
With relatives who sell agricultural products through the internet?			
Yes	183	68	32
No	67	34	66
Member of a cooperative?			
Yes	81	70	30
No	169	53	47
With e-commercial subsidy?			
Yes	13	100	0
No	237	57	43

CMCC = China Mobile, km = kilometer, m = meter, Unicom = China Unicom.
Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

Table 6.3 shows that the households with online sales are more aware of internet development, making payments over the internet, online shopping, and development of rural e-commerce than the households without online sales. A significant proportion of those surveyed do not have information about the internet, and the households without online sales account for most of these.

Table 6.3: Comparing the Information Awareness of Households With and Without Online Sales

Description	Number of Observations	With Online Sales (%)	Without Online Sales (%)
Total	**250**	**59**	**41**
Internet development			
Not aware	107	36	64
Below the average	30	50	50
Average	38	68	32
Above the average	54	89	11
Know it very well	21	90	10
Internet payments			
Not aware	87	31	69
Below the average	29	55	45
Average	30	50	50
Above the average	64	86	14
Know it very well	40	85	15
Online shopping			
Not aware	95	32	68
Below the average	28	64	36
Average	33	52	48
Above the average	58	81	19
Know it very well	36	97	3
Development of rural e-commerce			
Not aware	107	35	65
Below the average	37	62	38
Average	38	66	34
Above the average	41	90	10
Know it very well	27	93	7

Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

6.3. Major Factors at Individual Level

Out of the 250 household heads surveyed, women were outnumbered by men, with only 14 acting as heads of their households. Despite this, 71% of them are working in online sales (Table 6.4). The findings suggest that if the head of the household is a leader in the village, the household is more likely to be involved in online sales. Moreover, the head of the household is younger and higher educated, the household is more likely into online sales. It is noted that only 51 heads of the surveyed households have participated in any e-commercial trainings, and 80% of them have online sales.

Table 6.4: Comparing the Heads of Households With and Without Online Sales

Description	Number of Observations	With Online Sales (%)	Without Online Sales (%)
Total	**250**	**59**	**41**
By gender			
Male	236	58	42
Female	14	71	29
By whether the household head is a leader in the village			
Yes	35	69	31
No	215	57	43
By age			
<=35	15	93	7
35–60	171	59	41
>60	64	50	50
By education			
Elementary school	65	48	52
Junior middle school	109	57	43
High school or higher	76	71	29
Does the household head live in the village?			
Yes	232	59	41
No	18	56	44
Does the household head own a smartphone?			
Yes	191	63	37
No	59	46	54
Does the household head participate in any e-commercial trainings?			
Yes	51	80	20
No	199	53	47

Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

Table 6.5 shows that respondents from the households selling goods online have more contacts in their phones. For example, 109 respondents have more than 200 contacts in their phone directories, and 81% of them are from the households with online sales. The respondents from the households that sell online have more phone calls on average per day and use their phones for longer hours than households that are not involved in online sales. The findings also indicate how WeChat plays a significant role in online sales.

Table 6.5: Comparing Smartphone Usage Among Households With and Without Online Sales

Description	Number of Observations	With Online Sales (%)	Without Online Sales (%)
Total	**250**	**59**	**41**
Number of contacts in phone directory			
<=50	58	26	74
50–200	83	53	47
>200	109	81	19
Average number of phone calls per day			
<=5	120	43	58
5–20	107	70	30
>20	23	91	9
Number of hours of phone use per day			
<=2	123	36	64
2–5	79	77	23
>5	48	38	13
Using WeChat?			
Yes	209	67	33
No	41	17	83
Number of contacts in WeChat directory			
<=50	34	24	76
50–200	73	56	44
>200	102	89	11
Using WeChat moments?			
Yes	195	70	30
No	14	21	79
Frequency of use of Alipay or WeChat Pay			
Very few	77	21	79
Sometimes	34	35	65
Once a week	17	71	29
Three times a week	49	82	18
Every day	73	92	8

Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

6.4. The Barriers and Drivers of E-Commerce Development in Rural Areas of the People's Republic of China

The analysis of the barriers and drivers of e-commerce development gives some clues for investment in the strategy of developing the rural PRC. Table 6.6 presents the main barriers of operating e-commerce for the households that have had online selling experiences (i.e., e-commercial households). There are some differences in the extent of these barriers between e-commercial and non-e-commercial villages, but the biggest barriers for both is the lack of fresh-keeping and storing facilities, the high cost of logistics, a lack of operating e-commerce skills, and a lack of packing and marketing skills.

Table 6.6: Major Barriers to Operating E-Commerce for E-Commercial Households, 2017

Major Barriers	E-Commercial Village	Non-E-Commercial Village
Lack of operating e-commerce skills	27.5	28.9
High costs of logistics	33.0	34.2
Lack of fresh-keeping and storing facilities	48.6	36.8
Lack of packing and marketing skills	22.0	15.8

Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

Table 6.7 shows the main reasons for not operating e-commerce for the households with no online selling experiences yet (i.e., non-e-commercial households). For e-commercial and non-e-commercial villages, the main reason is the lack of operating e-commerce skills, lack of fresh-keeping and storing facilities, lack of packing and marketing skills, as well as the high costs of logistics.

Table 6.7: Major Reasons for Not Operating E-Commerce, 2017

Major Reasons	E-Commercial Village	Non-E-Commercial Village
Lack of operating e-commerce skills	68.3	69.4
High costs of logistics	9.8	12.9
Lack of fresh-keeping and storing facilities	46.3	29.0
Lack of packing material and marketing skills	19.5	17.7

Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

Based on interviews with farmers, local officials, and traders, the survey found the following major barriers to rural e-commerce development that are also consistent with the results presented in the preceding tables.

(i) **Logistics.** The cost of shipping agricultural products, especially from the farm gate to consumers are quite high. Most logistics companies establish their smallest offices in towns, rather than reach the villages directly, because of the high costs. In this case, farmers who sell their products through e-commerce would have to send their goods to the post offices in the town. This is inconvenient for the farmers and may also cause losses of agricultural products because of poor shipping and packing.

(ii) **Storage.** Small farmers do not have their own professional-quality storage. For example, apple farmers store their apples in the shared cold storages that are operated by local businessmen. This constrains the farmers from selling their apples online because the rented storages are not allowed to be opened casually. As such, farmers could not supply goods to consumers in time. Typically commercial orders are small, which leads to high labor costs.

(iii) **Characteristics of agricultural products.** Most agricultural products are fresh and seasonal. Ensuring the produce's freshness increases the costs of packing and shipping. Because crops are seasonal, supplies are unstable and requires spending on storage costs. Stocking goods also causes financial pressure considering that agricultural products are purchased during the harvest time and stored to be sold over the whole year.

(iv) **Human capital.** Operating online stores requires knowledge about computers and the internet, especially on the big e-commercial platforms like Taobao, etc. Farmers in the PRC are aging. Most of them are in their 50s and 60s, who are not familiar with using computers and smartphones. As such, many of them are not capable of running the online stores by themselves. Although some farmers use WeChat to sell their products, their potential consumers are very limited because the WeChat selling platform is limited to the available contacts. However, the social network of most farmers include local people who are not potential buyers of the farmers' agricultural products. Although local governments and organizations conduct trainings on e-commerce, these are often too theoretical and delivered in a way that is not easily understood by farmers. In addition, not all farmers have access to training opportunities.

(v) **Thresholds to start e-commerce.** Big e-commercial platforms typically require farmers to submit official certificates and documents for them to be able to sell food and related goods through their network. This means that small landholders who do not have the means to acquire these documents are automatically disqualified from selling their goods in these vast network.

Apart from the good condition of infrastructure, such as roads and internet, the other main factors driving e-commerce development in rural areas of the PRC include the following.

(i) **Well-founded agricultural industry.** There are many more possibilities to start e-commerce in regions where the agricultural industry is well founded. For example, Qixia city is famous for producing apples for years. The apple industry is its major agricultural industry and local farmers mostly plant apple trees. Before the advent of e-commerce, all of the apples had been sold by middlemen and local companies. More and more people have tried to sell their apples through e-commerce in recent years.

(ii) **Existence of large e-commercial retailers.** The successful cases of e-commercial retailers can stimulate local farmers to start their own e-commerce career, especially in the case of large e-commercial retailers who engage in selling local agricultural products.

(iii) **Social capital of farmers.** Farmers may start to engage in e-commerce if their friends, neighbors, or relatives are doing it. Farmers can learn about e-commerce from these contacts.

(iv) **Guidance of local government.** The local government plays an important role in developing local e-commerce. For example, more trainings targeted at farmers and advertisements on developing e-commerce in rural areas can raise the farmers' awareness on developing e-commerce. If local governments invest more on improving the infrastructure and connectivity in rural areas, such as internet connectivity and roads, this would enable farmers to engage in e-commerce.

Chapter 7

Likely Impacts of Applications of Information and Communication Technology in Agriculture

7.1. Income and Employment

The impacts of e-commerce are difficult to measure because of the endogeneity problem with farmers engaged in e-commerce. In this chapter, the average income and employment will be used to illustrate the likely impacts of e-commerce. Table 7.1 indicates that the average annual income of residents is higher in e-commercial villages than in non-e-commercial villages. Households in e-commercial villages have a higher share of self-employment in the off-farm sector than those in the non-e-commercial villages.

Table 7.1: Comparison of Household Average per Capita Income and Labor Employment between E-Commercial and Non-E-Commercial Villages

Description	Average Annual Income Per Capita (CNY)	Share of Self-Employment in Off-Farm Labor Over Total Labor(%)
E-commercial village	17,833	31.4
Non-e-commercial village	14,636	11.2

CNY = Chinese yuan.
Note: Self-employment in off-farm rural labor does not include farming own farmland or selling own agri-products.
Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

7.2. Differences in Selling Prices, Marketing Costs, and Price Margins

Based on the survey in Shandong and Zhejiang, this report examines the differences in the prices and costs of marketing for major products between online sales and offline sales. It is noted that in the samples, there are some cases where households sold products to middle agents that eventually reached the market online, but the households received the same prices between the above channel and offline sale (farm gate). The analysis in this report does not include the above indirect online sales. Table 7.2 presents the online and offline selling prices of apples, peaches, pecans, kiwifruits, and sweet potatoes. In general, the online selling prices for all products are higher than the offline selling prices. Lower-grade products are not often sold online but rather offline.

Table 7.2: Online and Offline Selling Prices

Description	Online Sales			Offline Sales		
	2015	2016	2017	2015	2016	2017
Apple						
First class	12.2	11.9	12.0	7.6	6.9	7.1
Second class	9.1	9.0	9.0	4.9	4.3	4.5
Peach						
First class	15.0	15.0	15.1	7.3	7.7	7.7
Second class	10.2	9.9	10.1	4.5	5.0	5.0
Third class	9.7	9.1	8.5	3.2	2.9	3.2
Pecan						
Highly processed	164.8	175.2	177.8	154.4	161.2	170.2
Processed	111.4	108.8	113.8	97.8	98.6	98.4
Roughly processed	94.0	101.3	99.9	58.6	59.8	56.0
Kiwifruit						
First class	35.2	33.4	34.4	18.0	20.0	21.4
Second class	25.3	29.8	25.4	13.0	15.4	14.6
Third class	19.7	23.0	18.0	8.5	8.7	8.9
Sweet potato						
First class	13.3	12.8	12.2	7.0	8.3	6.3
Second class	11.2	8.2	11.6	6.4	5.1	6.0
Third class	8.5	6.5	6.5	3.8	3.6	3.5
Mixed	9.5	10.5	11.4	6.1	7.4	6.1

CNY = Chinese yuan, kg = kilogram.
Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

Table 7.3 presents the online and offline marketing costs. The results show that online selling costs for all products are much higher than those of offli ne selling. For example, the online selling cost of first-class apples was four times higher than the offline cost in 2017. Similar results were found for all the other products.

Table 7.3: Online and Offline Marketing Costs

	Online Sales			Offline Sales		
Description	2015	2016	2017	2015	2016	2017
Apple						
First class	3.5	3.8	3.9	0.8	0.8	0.8
Second class	3.6	3.8	3.8	0.8	0.8	0.7
Peach						
First class	4.7	4.5	4.4	0.7	0.8	0.8
Second class	4.5	4.9	4.8	0.7	0.7	0.8
Third class	5.2	5.2	4.9	0.7	0.7	0.6
Pecan						
Highly processed	16.8	17.6	17.2	14.6	16.4	16.0
Processed	12.1	12.8	13.6	6.6	6.6	6.8
Roughly processed	13.7	15.3	16.4	1.0	0.8	1.2
Kiwifruit						
First class	4.8	4.6	4.8	0.6	0.6	0.7
Second class	4.4	4.4	4.6	0.8	0.6	0.7
Third class	4.8	5.5	5.1	0.8	0.7	0.6
Sweet potato						
First class	2.8	2.9	3.2	0.3	0.3	0.3
Second class	2.4	3.1	3.1	0.3	0.2	0.3
Third class	2.5	2.6	2.8	0.5	0.5	0.4
Mixed	3.2	2.6	2.4	0.3	0.3	0.3

CNY = Chinese yuan, kg = kilogram.
Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

Table 7.4 presents the difference of price margins (selling price minus marketing cost) between online and offline selling. Notably, selling costs do not include any fixed cost and salary for self-employment. The price margin of apples through online sales is slightly higher than that of offline sales. The price margin of peaches through online sales for all grades is higher than offline sales. Although processed pecans sold online have a lower price margin, the highly processed and roughly processed pecan sold online has higher price margins. The price margin of kiwifruits sold online for all grades are higher than those sold offline. Similarly, the price margin of sweet potatoes sold online for all classes are higher than those sold offline. The results presented in Table 7.4 suggest that the price margin for goods sold through the internet is generally

higher than those for products sold offline. However, online sales also entail a higher fixed cost through investment and more self-employment that have not been taken account in the above analyses.

Table 7.4: Comparing Price Margins of Online and Offline Sales, by Commodity (CNY/kg)

	Online versus Offline Sales		
Description	2015	2016	2017
Apple			
First class	1.9	2.1	1.8
Second class	1.5	1.7	1.4
Peach			
First class	4.2	3.7	3.8
Second class	2.0	0.8	1.1
Third class	2.1	1.8	1.2
Pecan			
Highly processed	8.2	12.8	6.4
Processed	8.1	4.0	8.6
Roughly processed	22.7	27.0	28.7
Kiwifruit			
First class	13.0	9.4	8.9
Second class	8.7	10.6	6.9
Third class	7.3	9.5	4.6
Sweet potato			
First class	1.9	1.9	3.0
Second class	2.6	0.2	2.8
Third class	2.7	0.8	0.6
Mixed	0.5	0.8	3.1

CNY = Chinese yuan, kg = kilogram.
Note: Cost excludes fixed cost and salary for self-employment.
Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

Chapter 8

Investment in Information and Communication Technology in Agriculture and Rural E-Commerce

8.1. Investment by Households on Fixed Assets

Table 8.1 documents major investments in fixed assets by e-commercial households, including office sites, internet facilities, transporting vehicles, warehouses, and processing facilities. In general, almost half of the households surveyed have invested in office sites and internet facilities (computer, printers, etc.). About 25% of the surveyed households have invested in transportation vehicles and warehouses while 14% invested in processing their own products. Compared with Shandong province, there is a higher percentage of households in Zhejiang that have invested in these fixed assets for undertaking e-commerce. For different e-commercial modes, the households that only use WeChat to sell agricultural products invested much less in fixed assets for operating e-commerce.

Table 8.1: Percentage of Households that Invested in Fixed Assets, by Different Provinces and E-Commercial Mode

Description	Number of Observations	Office Sites (%)	Internet Facilities (%)	Transporting Facilities (%)	Storing Facilities (%)	Processing Facilities (%)
Province						
Zhejiang	91	44.0	54.0	31.7	33.7	18.7
Shandong	56	39.3	43.0	21.4	14.3	5.4
E-commercial mode						
WeChat	66	15.2	21.2	21.2	9.1	6.1
Online store	22	54.6	27.3	27.3	13.6	9.1
Informal cooperation	3	100.0	66.7	66.7	100.0	0
Cooperative	11	54.6	18.2	18.2	45.5	18.2
Total	**147**	**42.2**	**50.0**	**27.8**	**25.9**	**14.0**

Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

Table 8.2 shows that the average fixed costs invested by e-commercial households of Zhejiang province are higher than that of Shandong. The e-commercial households that use WeChat to operate e-commerce have the lowest investment.

Table 8.2: Average Annual Fixed Costs per Household, by Province and E-Commercial Mode (CNY '000)

Description	Number of Observations	Total Fixed Cost	Office	Office Facilities	Internet	Transporting Facilities	Storing Facilities	Processing Facilities
Province								
Zhejiang	91	128.9	14.1	1.3	2.8	32.3	26.9	51.6
Shandong	56	146.5	0.4	0.7	2.3	11.8	76.7	5 1.0
E-commerce mode								
WeChat	66	19.0	0.3	0.1	1.1	8.6	5.7	0.3
Online store	22	70.6	0.5	1.1	3.2	9.3	10.1	41.4
Informal cooperation	3	206.0	41.7	4.3	8.3	40.4	111.2	0
Cooperative	11	124.8	0.6	2.4	3.1	66.5	41.7	5.2
Total	**147**	**130.4**	**10.5**	**1.1**	**2.5**	**26.4**	**37.4**	**52.5**

CNY = Chinese yuan.
Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

In general, e-commerce households invest an average of 0.8 internet facilities and own 1.7 vehicles to operate (Table 8.3). E-commerce households in Zhengjiang invested more than Shandong and households that sell their products on WeChat invest much less in internet facilities.

Table 8.3: Fixed Assets on Internet and Transportation Owned by E-Commercial Households

Description	Number of Observations	Number of Internet Facilities	Number of Transport Vehicles
Total	**147**	**0.8**	**1.7**
Province			
Zhejiang	91	0.9	1.5
Shandong	56	0.6	2.3
E-commerce mode			
WeChat	66	0.2	1.8
Online store	22	0.8	1.7
Informal cooperation	3	1.3	2.0
Cooperative	11	1.2	2.7

Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

8.2. Investment by Households for Variable Assets

Table 8.4 presents the variable costs for operating e-commerce, including the costs for e-commercial platforms, platform advertisements, platform services, and labor. The results show that labor accounts for the largest cost. Households in Zhejiang spent more on variable costs mainly because Zhejiang had higher local wages than Shandong. Using e-commercial platforms, advertisements, and employment cost almost nothing for online sales done through WeChat.

Table 8.4: Average Annual Variable Costs per Household, by Province and E-Commercial Mode
(CNY '000)

Description	Number of Observations	Total Variable Cost	E-Commercial Platform	Platform Ads	Platform Services	Labor Cost
Province						
Zhejiang	91	70.9	5.6	13.1	0.2	50.0
Shandong	56	38.9	0.5	3.3	4.2	30.9
E-commerce mode						
WeChat	66	0.3	0.2	0.1	0.03	0
Online store	22	54.8	0.4	7.9	10.4	36.0
Informal cooperation	3	73.3	16.7	20.0	11.7	25.0
Cooperative	11	70.9	8.5	4.1	5.3	53.0
Total	**147**	**58.7**	**3.6**	**9.4**	**2.9**	**42.8**

CNY = Chinese yuan.
Source: Authors' compilation based on data from the third-round survey on e-commerce of the China Center for Agricultural Policy.

Chapter 9

Conclusion and Policy Implications

9.1. Summary

In general, the development of information and communication technology infrastructure in rural villages has been impressive. Currently, all villages have access to mobile phone services, and about 70% of them also have access to the internet. One-fourth of the villages have business offices opened by at least one of the major telecommunications companies. Transportation infrastructure has also developed rapidly in rural areas of the People's Republic of China (PRC). More than half of the surveyed villages are within 5 kilometers (km) of a national highway. The average distance to the nearest provincial highway is 7.5 km and 3.4 km to the nearest county paved road.

Logistics services have started to become available in some rural villages. Among this study's 126 sample villages, 26% have access to package delivery services by private firms within their villages. For other villages, the average distance to a package collection and/or distribution point is 4.5 km. The public postal services have a similar coverage. Some 15% of villages have a post office, and nearly 40% have one or more mail carrier serving their villages. For the remaining villages, the average distance to the nearest post office is 5.2 km.

Many farmers have a smartphone and use it extensively. Among 4,833 individuals aged 16 or above in the survey sample, 89% have a mobile phone, 71% of whom own a smartphone. Mobile internet is becoming more important in internet access. No fewer than 87% of the smartphone owners surveyed use their device as their major channel to access the internet, with the others using desktop computers. The most popular function of smartphones is social networking, used by 84% of smartphone owners. Smartphone owners also access the news (68%), watch videos (67%), and other entertainment (64%). Around half of the surveyed smartphone users use it for shopping (49%) and payment (52%). Only 5% sell products and services on smartphones.

Government support for e-commerce focuses on the construction of industrial parks. More than half of the sample counties had introduced policies to enhance the development of e-commerce by 2017. Most public investment has been made in infrastructure, more specifically, the construction of e-commerce parks. To attract more firms to these parks, governments also offer preferential rent and utility pries to firms operating there. Such e-commerce parks are mostly located in the county sit or township. It is worth noting that this support is for e-commerce at large, not particular to agricultural e-commerce.

Currently, while the e-commerce is emerging in rural areas of the PRC, the penetration of e-commerce into rural areas is still limited. Among the 1,273 households in this survey, only about 2% sold agricultural products on the internet in 2016. These products are mainly vegetables and fruits. The shares of online sales in total sales vary among these households and concentrate on two ends. Four households sell all their products online while others sell less than a third of their products online. These two ends are examples of different penetration. Even fewer households (13 out of 1,273, or 1%) purchased agricultural inputs on internet. The inputs purchased on the internet are mainly pesticides and herbicides. With regard to mechanical services, only five (0.4%) households purchased the service through the internet in 2016. The services they purchased online are tillage, sowing, and harvesting—the main services purchased by all farmers both online and offline. Other services such as application of pesticide and fertilizer are purchased through channels other than the internet.

Over a quarter of farmers are willing to sell their agricultural products through e-commerce. In the sample, 27% of the households expressed their willingness to sell their agricultural products online because they believe that selling online could net them higher prices, offer greater convenience, and give them access to a larger group of potential buyers. There are fewer households that are willing to purchase agricultural inputs online but those who are think that online purchases are more convenient and can give them lower prices.

Many farmers are facing capacity, investment, and logistics constraints to engage in e-commerce. Of households surveyed 69% said that they are not willing to sell online because they do not have the necessary knowledge and skills to operate, are not equipped with storage and preservation facilities, not encouraged by the high logistic costs, and do not have the ability for marketing expansion. The respondents who said that they are not willing to buy agricultural inputs online said that it is because they find it hard to trust the quality of the products.

Nearly one-fifth of the farmers surveyed are willing to buy agricultural inputs through e-commerce. The major advantages they perceive in buying agricultural products online are the convenience it offers as well as the potential lower prices. The farmers who said that they are unwilling to purchase inputs online cited their lack of knowledge and skills, poor trust in online transactions, and high uncertainty on the quality of the products as major reasons.

E-commerce is likely to raise farmers' income and self-employment. Agricultural commodities sold online cost higher than those sold offline. Although the marketing cost of selling products online is generally also higher, farmers can gain more net profits through online sales. E-commerce is also expected to increase farmers' self-employment as online selling is more labor-intensive than offline selling.

While the potential is high, the expansion of agricultural e-commerce is also facing several challenges. The most frequently mentioned challenge is the storage and transportation of fresh agricultural products. Due to the limited availability of appropriate equipment, it is difficult to transport agricultural products over a long distance while preserving their freshness. As a result, the products suitable for

online sales are limited and so is the range of potential buyers. The second biggest difficulty lies in marketing. Because of information asymmetry associated with online transactions, which is more severe in agricultural products, the trust of buyers and hence their willingness to buy agricultural products online is still not high. The required investment at the beginning is also high, and usually prohibitive for small farms without external support. Even after a successful startup, sustaining the business is still challenging.

9.2. Major Policy Recommendations

Invest in storage and transportation for the development of e-commerce in agriculture. As revealed by the interviews, the biggest challenge faced by agricultural e-commerce is the storage and transportation of fresh agricultural products. Improvement of storage and transportation conditions make it possible for more agricultural products to be sold online across longer distances and larger areas, and hence more consumers. This will enhance the development of agricultural e-commerce significantly.

Invest in farmers' capacity building through practical training on how to operate e-commerce. To address the problem of the lack of knowledge and skills in operating e-commerce enterprises cited by a majority of households, rural residents should be provided with more practical training on how to operate and manage e-commerce businesses.

Provide financial and credit support for farmers, particularly to small farmers, in e-commerce business. E-commerce requires major investments in fixed assets, particularly transporting vehicles, office and internet facilities, warehouses, and processing facilities.

Diversify e-commercial modes. Considering that the social capital of individual households is often limited and that they lack skills in marketing and operating e-commerce enterprises, it would be helpful to promote linkages between farmers and professional companies and agents.

Improve market regulations and favorable market environment for the development of agricultural e-commerce. The perishable nature of agricultural products makes it difficult to trust online transactions. Efforts should be made to tighten regulations and develop dispute settlement mechanisms to build the trust of consumers in purchasing agricultural products online. This can facilitate the development of agricultural e-commerce.

Pay attention to the impact of e-commerce on income inequality. The development of e-commerce is not unconditional, nor does it impact different people equally. Regions with better infrastructure and locations are more likely to benefit from e-commerce. Farmers with relevant knowledge and skills and other resources may benefit more from e-commerce. At the same time as promoting

agricultural e-commerce, the government should pay attention to those who may not benefit that much from, or even be hurt by the development of agricultural e-commerce. Only in this way can the government foster the inclusive development of agricultural e-commerce.

Application of Information and Communication Technology for Agriculture in the People's Republic of China

This report presents the findings of an assessment on the use of information and communication technology (ICT) to improve food production and distribution in the People's Republic of China. The analysis focuses on e-commerce in rural areas of the country and provides policy recommendations to promote the use of ICT in the agricultural supply chain. The report documents the trends in ICT application by farmers and its impact on income and livelihood. It also identifies the major constraints to and enabling factors for such ICT applications.

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