An Analysis on Innovative Research Fronts for the Information-based Agriculture in China

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Against the historical backdrop of synchronizing industrialization, informationization, urbanization and agricultural modernization in China, it is of a material immediate significance to clearly define research priorities and development orientations for the future in the field of information-based agriculture. This article, through summarizing the status quo and the latest developments in the field of China’s research into the information-based agriculture, specifically proposes certain scientific problems and key technologies for future research in the area of information-based agriculture, and gives a systematic analysis on major items for research in the area of China’s information-based agriculture for the next 5 to 10 years.

Keywords: Agriculture, Informationization, Information Technology, Trend Analysis.

1. Introduction

In today’s China, the call of the time is the synchronization of industrialization, informationization, urbanization and agricultural modernization. In its annual No. 1 Circulars, the Central Government has been paying attention to the informationization process relating to agriculture and the rural areas: in its No. 1 Circular for the year of 2014, the central government points out that “we shall build a technology system for the whole-process of agricultural informationization and mechanization with agricultural internet of things and equipment for precision agriculture as its priorities”; and in its No. 1 Circular for the year of 2015, the central government points out that “we shall further advance the connections of radio, television and telecommunication facilities’ connection to each village, facilitate construction of the information technology infrastructure and extension of broadband facilities in the rural areas, so as to promote the information accessibility to each household”. Therefore, in the matter of how to transform, guide and develop the agriculture sector in China with contemporary information technologies, so as to enhance labor productivity in the agriculture sector and its core competency, and speed up the nation’s progress in agricultural modernization, it is a pressing need to clearly define the scientific
problems, key technologies and major items requiring urgent attention for the nation’s information-based agriculture in the foreseeable future upon a clear understanding of the latest research developments.

2. Status Quo and Latest Developments of the Research on Information-Based Agriculture in China

In China, the process of information-based agriculture started at a later date, and the nation is currently still lagged behind to certain extent as compared with the advanced counties in the world. The gap between China and those advanced countries is reflected in the following areas: theories and methodologies for the information-based agriculture, policies on the information-based agriculture, the Internet plus-based agricultural modernization and etc.

2.1 The Latest Developments in Research on Theories and Methodologies for the Information-based Agriculture

In the advanced countries across the Western World, the integration of human, machinery and things has been accelerated through innovations in theories and methodologies for informationization, which integration has in turn facilitated the development of the Internet of things in the agriculture sector, significantly enhanced the levels of their information-based agriculture, and become an important driving force behind a rapid growth of their contemporary agriculture. China is now in a crucial period for transforming its traditional agriculture into a contemporary agriculture, so the theories and methodologies for the information-based agriculture are of vital importance, as they will have outstanding effects on guiding the nation’s efforts in the information-based agriculture, facilitating the nation’s level of agricultural industrialization, promoting the intensified agriculture, as well as facilitating transformation, upgrading, and quality and efficiency enhancements in the agriculture sector.

However, in China, there are some outstanding issues in terms of theories and methodologies for the information-based agriculture, and they are: (1) the nation has no overall plans in these fronts due to its poor awareness; (2) progress in theory and methodology is rather slow due to a late start in relevant research; (3) funds are insufficient and the research institutions are not paying enough attention; (4) the research ability is weak due to talent insufficiency; and (5) level of the information-based agriculture is low, and there are no opportunities to apply those theories and methodologies for the information-based agriculture.
2.2 Status Quo and Latest Developments of Policies on the Information-Based Agriculture

In such advanced countries as the United States, Germany and Japan, a whole-process of the IT system for agriculture with national infrastructure as the backbone has been established, which system is developing into such orientations as integration, specialization, Internet-based, multimedia-based, application and extension. In China, although the nation started the whole-process of its agricultural informationization at a later date, but thanks to an implementation of its Information-based National Development Strategy, the nation has carried out numerous explorations in the field of the whole-process of agricultural informationization, and has achieved certain tangible effects, but China is currently still lagged behind to certain extent as compared with the advanced counties in the world, and the gap is reflected in the following areas: in the field of application of key technologies for the whole-process of agricultural informationization, the nation is yet to establish a perfect technology system, and the nation lacks the innovation ability for key technologies for the whole-process of agricultural informationization; in the field of development level of the whole-process of agricultural informationization, the nation is lagged behind in terms of its agriculture standards, top-down designs are absent, development and application of information resources are insufficient, methodologies for the whole-process collection and process of agriculture information are outdated, information service products are insufficient, and research on application systems fails to satisfy development needs from the agriculture sector and the rural areas; and in the field of innovating the mechanisms and patterns for agriculture-related comprehensive information services, the nation is yet to establish its comparatively perfect mechanisms for agriculture-related information service with Chinese characteristics, as for agriculture-related information services, there are no systematic designs or, overall advancements, there are no relevant standards or codes, and there are no endogenous impetuses to serve the farmers, so continued explorations and in-depth researches into the patterns of agriculture-related information services are required.

2.3 The latest development in researches on information classification and evaluation of supply and demand on agricultural products

Since 2000, the supply and demand on agricultural products in China have been basically balanced. The nutrition and health of Chinese people have been improved significantly. Food and nutrition development have made remarkable achievements. However, agricultural product safety is still confronted with big
challenges. There are urgent needs for information analysis and services in this respect. Firstly, the sustainable development of food production have been affected by growing constraints on resources, worsened environment pollution in agricultural and rural area, and significant degradation of ecosystems. On the contrast, rigid demand on agricultural products has been growing in China. Consequently, the contradiction of ensuring food safety and the constraints on food resources become increasingly acute. It is urgent to promote researches on agricultural product safety and to make recommendations on food safety strategies and policies. Secondly, prices of some agricultural products have been fluctuated drastically due to spatial matching, temporal matching, quantitative matching and species matching of the production and consumption of agricultural products. Sometimes, supply and demand on agricultural products become imbalance regionally, seasonally and structurally. Researches on safety and development of agricultural products should be immediately developed to contribute measures and recommendations on matching their production and consumption. At last, different regions and divisions haven't unified and linked up the processes of collecting, defining, describing and applying the information of agricultural products. Therefore, the information from different sources, processes and regions lacks comparability. There is a strong need of establishing a specification on information classification that covers multiple dimensions, links up separated processes, and has coherent connotations.

2.4 Status quo and development of Internet plus-based agricultural modernization

China has attached great importance to modernization of Internet plus-based agriculture. "Internet plus" was for the first time elevated to an altitude of national strategy in the report on the work of the government in 2015. The combination of "Internet plus" and traditional agriculture will give birth to an agricultural "Internet plus" which will bring new opportunities to modern agriculture and its healthy and sustainable development. Internet plus-based agriculture makes use of the inherent advantages of the Internet to explore the growth potential of traditional agriculture and update the traditional industry chain of agricultural production, circulation and sales. It improves agricultural production level and quality control of agricultural products, promotes production efficiency, reforms industrial structure and keeps an open channel for market information and circulation. At last, there will be an Internet Plus-based agricultural ecosystem which integrates production, monitoring and management. It will significantly improve production efficiency, quality and benefits on agriculture.
3. Several scientific issues and key technologies of information-based agriculture in future researches

In the next 5-10 years, agricultural information research needs to focus on two major scientific issues and two key technologies. The issues including measuring information level of the whole-process information-based agriculture and evaluating the model of agricultural information service. Two key technologies are means to resolve these problems.

3.1 Two major scientific issues

One is the determination of agricultural informationization level. The Eighteenth National Congress of the Communist Party of China put forward a strategy of "promoting harmonized development of industrialization, IT application, urbanization and agricultural modernization." IT application has been promoted to a national altitude. The difficulty of quantitatively measuring the level of whole-process information-based agriculture has been increased with the rapid development and growth of emerging technologies such as large data, Internet of Things, cloud computing and precision equipment, and with the application of new information technologies in agriculture. Meanwhile, several factors in whole-process of agriculture informationization should be considered, including environment, industry, basic conditions, human resources and development potential. Therefore, it is a major scientific issue to quantitatively and accurately measure the information level in the whole-process information-based agriculture.

The second issue is how to construct agricultural information service system. Agricultural information service is strategically important in supporting the development of the agricultural information. It is essential for making the most of superimposed effect of agricultural modernization and informationization. It is also a major way to compensate the urban-rural digital divide and to coordinate the economic development of urban and rural areas. The priority among priorities in our economy, especially the sustainable development of economy in agricultural and rural areas, is how to accelerate the transformation of agricultural information service from technical service only to comprehensive information services, from government only to government-enterprise-society cooperation, from targeting "agriculture, farmer and rural area" to targeting urban-rural integration development. Another priority is to develop an information service model that is suitable for different provincial characteristics, social conditions, public conditions and agricultural conditions.
3.2 Two key technologies

The first one is the technology of measuring level of whole-process of agriculture informationization. Based on the principles of dominance and pertinence, an indicator system should be constructed integrating agricultural information environment, industry, basic conditions, talents and development potentials. A single-factor measure module for determining information level of whole-process information-based agriculture will be constructed by using traditional measure methods such as social informationization index method, exponential model of information utilization potential, and analytic hierarchy process, and by using smart measure methods such as genetic algorithms, neural networks and support vector machine. The method of weighing should be used to create a measure model for determining the information level of the agricultural process.

The second is the technology for evaluating agricultural information service. Empirical analysis, analytic hierarchy process, fuzzy comprehensive analysis method, Internet plus-based thinking and large data analysis techniques will be used to construct a hierarchical and all-round indicator system which integrates social, economic and ecological benefits. A model for comprehensively evaluating agricultural information service types will be developed to quantitatively compare and analyze the discrepancies of various information service models.

4. Main orientations of agricultural informationization research in the future

According to the development practices of agricultural informationization, main innovations include: researches on agricultural information theory and technology, animal husbandry and veterinary information analysis, information matching techniques for food production and consumption, simulation techniques for agricultural product safety, standards for agricultural information classification.

4.1 Researches on agricultural information theories

Comparative studies on agricultural informationization should be carried out to study its developments, trends and evolutions in our country and typical developed countries, which will be used as the basis to make policy recommendations on promoting agricultural informationization in China. Empirical studies on agricultural informationization should be developed, focusing on engineering theories of information accessibility to each households
and regional trial of agricultural Internet of things. Researches should be done to evaluate the progress of Internet of things. On the basis of data from the integrated service platform of agricultural Internet of things, indicators and models should be built to develop methods of evaluating perceptive technology of Internet of things, transmission technology and levels of application technology. Efforts should be made on measuring the level of agricultural informationization. Scientific and reasonable indicator system should be developed to explore the quantitative study on determining the level of information-based agriculture in China. Researches should also focus on the effects of agricultural informationization policy. By optimizing and analyzing the policies that are valid or to be implemented with mathematical model and analogue simulation, the best policies will be screened.

4.2 **Researches on agricultural informationization technologies**

By studying agricultural informationization technologies such as Internet of pastures and Internet of gardens, key technologies and technical systems for whole-process informationization will be developed for agricultural production, operation, management and service. With studies on agricultural information service technologies, its service mechanism will be explored according to the efforts on information accessibility to each household, regional trial of Internet of things, key laboratories of information service. Differential effects of different regions should be studied for suggesting an agricultural informationization mechanism with Chinese characteristics. Efforts should be made to research rural e-commerce technology. As e-commerce is developing rapidly, the Internet plus-based rural e-commerce issues should be studied to stipulate relevant standard system, to make policy recommendations on selling agricultural products in the town and selling novel industrial products in the countryside and to stimulate the development of new forms of circulation in rural areas. On the basis of harmonizing the Four Modernizations, Internet plus-based modern agriculture will be studied to find out the opportunities and challenges in promoting agricultural modernization in the Internet plus-based environment, to explore a path of developing Internet plus-based modern agriculture that is suitable for China's national conditions, social conditions and agricultural conditions. As to different fields in agricultural industry, for example, Internet plus-based husbandry, Internet plus-based planting and Internet plus-based aquatic, their differential effects and route optimization will be studied. With respect to increasingly open domestic and foreign markets for agricultural products, investigate the issues of exporting Internet plus-based agriculture and
analyze the path, support measures and policy recommendations of exporting agricultural enterprises, capitals, talents and technologies with Internet plus-based mind.

4.3 Researches on information analysis technologies of animal husbandry and veterinary

Efforts should be made to carry out researches on livestock production and market information perception. The data and information perceived or obtained via Internet of things or large data technologies will be used to explore the pattern that information flow changes during livestock production and animal products circulation, and to study the whole-process information in animal production activities. The method to perceive holographic information of livestock product market should be studied. The whole-process data of quality safety from pasture to table will be used as the basis to study a method that can trace the source of a product. Econometrics will be used to build models for analyzing prices, supply and demands of livestock products. It will also be used to construct and improve a system for modern livestock production and market information perception. The model for monitoring and analyzing the information of animal epidemic diseases should be developed. A database of growth characteristics should be built for normal animals and epidemic animals by collecting and storing data of physical appearance, size parameters, vital signs and behavioral characteristics during animal growth process. After the video and image information of animals are collected, early warning method should be explored for animal epidemic diseases and a model to monitor and analyze animal epidemic information should be built according to typical early characteristics of the diseases. Researches should be carried out to monitor and analyze the livestock breeding environment. By analyzing the factors that affect the growth of livestock, a livestock monitoring system should be developed by screening indicators for monitoring the environment inside and outside the stall and the sewage disposal conditions. Explorations will be made for means and methods in long-term monitoring of livestock breeding environment. The model to analyze animal growth environment will be researched and developed. Efforts will be made to put forward policy proposals on cleaner livestock production.

4.4 Researches on matching information of food production and consumption

Researches on matching information of food production and consumption will be carried out by providing measure analyses from spatial, temporal, quantitative
and species perspectives, to put forward suggestions on improving supply-demand matching of agricultural products. Efforts will be made to research the spatial pattern changes and driving mechanism of major agricultural products and to analyze the characteristics of such changes and factors that influence them. The industrial development effect that they bring will be discussed for putting forward suggestions on optimizing the spatial arrangement of main food productions in China. Researches will be carried out on studying the characteristics of food consumption movement. By thoroughly studying the changes of food consumption and characteristics of consumption behaviors in different stages of social development from the perspectives of region difference, population structure and demographics, policy suggestions will be made on a new food development model which focuses on nutrition-oriented consumption and consumption-oriented production, to meet the nutrition needs and health destinations of Chinese people.

4.5 Researches on technologies for simulating the quantity and safety of agricultural products

Theoretical discussions will be held for food safety. On the basis of new food safety concepts of China, the characteristics of food safety evolution will be screened to determine the meaning of food safety under new situation and to scientifically judge and new opportunities and challenges of food safety in China. Researches on food safety in quantity will be carried out to explore main influential factors. An evaluation indicator system will be built to systematically evaluate food safety in quantity in the country, in different regions and in each household. Efforts will also be made to simulate food safety and develop supply-demand matching and simulation systems for major agricultural products. The safety of agricultural products in a variety of scenarios will be simulated with respect to changes in future population structure, resource and environment conditions, diet structure and marketization levels. Food safety strategies will also be researched by using the experiences of advanced countries on food safety management. Major tasks and measures will be determined for national food safety strategies. Suggestions on safety strategies and policies of agricultural products in China will be put forward.

4.6 Researches on the standards for information classification of agricultural products

The categories of agricultural products will be studied. On the basis of natural attributes of the agricultural products and their social and economic attributes in
processing and consumption processes, major products will be studied for refining their internal structures and connections. Classification criteria and coding system for agricultural products in China will be established. Efforts will be done on a standardized information model. Holographic information science will be introduced for in-depth analysis of data dimensions that are necessary in analyzing agricultural products information. An information theory model that covers defined data of agricultural products, data of corresponding environment and data of their interconnection. Information service specifications will be developed for in-depth analysis of demand differentiations of information service clients, for exploration of multiple service channels supported by new technologies and for establishment of specifications on information services. (This work is supported by Beijing Natural Science Foundation under its pre-research project entitled A Research on the Monitoring and Alarming System for Beijing Pork Market Integrating Data from Multiple Sources (Project No.: 9153023)).

References