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STUDY ON THE FRAMEWORK SYSTEM OF DIGITAL AGRICULTURE

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ABSTRACT: China is a great agricultural country with large population, limited soil resources and traditional farming mode, so the central government has been attaching great importance to the development of agriculture and put forward a new agricultural technology revolution — the transformation from traditional agriculture to modern agriculture and from extensive farming to intensive farming. Digital agriculture is the core of agricultural informatization. The enforcement of digital agriculture will greatly promote agricultural technology revolution, two agricultural transformations and its rapid development, and enhance China's competitive power after the entrance of WTO. To carry out digital agriculture, the frame system of digital agriculture is required to be studied in the first place. In accordance with the theory and technology of digital earth and in combination with the agricultural reality of China, this article outlines the frame system of digital agriculture and its main content and technology support.

KEY WORDS: digital agriculture; framework system; 3S technology; spatial data

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1 INTRODUCTION

The digital agriculture, with the help of basic research work and technical supporting system about digital earth (GORE, 1998), build feasible, scattering and open information network to serve for the agricultural production, management, sustainable development, environment protection, research and knowledge propagation through software development and hardware integrity. Digital agriculture is one of the most important parts of digital China and digital earth, and is the specific form of digital China. Some content of digital agriculture has been put into use in most of the developed countries. It was reported in the Review of China Agricultural Science and Technology that in America 82% of soil sampling is done by GIS, 74% drafted by GIS, 38% of harvesters attached to yield-surveying instruments, 61% of agriculture used yield analysis, and 90% of agriculture used accurate agricultural technology. The United States also has information managing system of crop strains throughout the nation, and the information of 600 000 sample plants has managed by computers. The Plant Protection Bureau of French Ministry of Agriculture has built nation-wide computer networks to survey and forecast diseases and insects, which can provide the true picture of diseases and insects, the forecast of chemicals and the evaluation of chemical remains. The Japanese Province of Agriculture, Forestry and Aquatic Products has built data bank system of many crop strains, such as rice, soybeans and wheat, etc. The Research Academy of New Zealand Agriculture and Husbandry provide all sorts of information services, the so-called "farm system" (OUYANG and ZHANG, 2001), the measuring of soil fertility, animal inoculation immunity, the construction of grassland and forage quality analysis. The implementation of digital agriculture helps their countries' agriculture grow rapidly, greatly increases the mechanization and the quality of produces, impels the technology revolution of agriculture, brings their countries' greater economic and social benefits, and at the same time provides us with experiences for reference.

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China is a great agricultural country, while the research work and application of agricultural technology still remain backward. Large population, limited soil resources, traditional mode of agriculture production, and frequent natural disasters are the national conditions of China. The central government has been attaching great importance to the development of agriculture. After the 3rd Plenary Session of the 15th Central Committee, the Chinese government held a meeting concerning rural tasks. The Ministry of Science and Technology held the meeting of agriculture information technology to carry out the plan of agriculture technology revolution presented in the 3rd Plenary Session, which could help traditional agriculture transform into modern agriculture, and extensive farming into intensive farming. In the meeting, some advice of promoting Chinese agriculture information was proposed. The Ministry of Science and Technology actively organized all units concerned, and increased the expert system demonstration areas to bring along the national agricultural informatization (CUI and LI, 1999). Digital agriculture is the core of agricultural informatization. Digital earth and digital China bring about the further development of digital agriculture, which can promote agriculture technology revolution, two transformations of agriculture and agricultural development. Digital agriculture is one of the points of contact and penetration of digital China and digital earth.

In the new century, agriculture will turn into water-saving agriculture, mechanical and intelligent agriculture, and high-quality, high-yield, pollution-free agriculture. After China's entrance to WTO, to enhance the competitive power and win the international market, farmer need high-tech to reduce costs, readjust plantations, renew produces and improve crop quality. Also farmers urgently need to know what and how to plant, the yield, the sell and the profits, etc. Digital agriculture is a necessary and effective approach. Through the computer network, farmers can obtain high-resolving-power satellite photographs of their own crops, from which they can obtain the growing information of the crops. By GIS analysis farmers can make out a plan accordingly. With the help of GPS and digital map, trucks can conduct farm work and we can prevent diseases and insects in time, furthermore, with pesticides, fertilizers and water being put where necessary, soil, grain, vegetables and seeds can avoid being polluted by chemicals.

Priority should be given to the frame system research of digital agriculture in the development of digital agriculture. Because of the novelty of this concept, the main research of the advanced countries is precision agriculture, which is only one of its important parts. For the present, there's no report on the research of digital agriculture frame system in the journals or other media home and abroad. The purpose of this research is to promote the development of digital agriculture and help the Chinese agriculture catch up with the international advanced level.

2 ANALYSIS ON THE FRAMEWORK SYSTEM OF DIGITAL AGRICULTURE

Digital agriculture, based on vast field cultivation, is an intensifying and information agriculture technology system with advanced high-tech as the support, and it makes the whole farming process digitalized, network-like and intelligent from plowing, sowing, fertilizing, irrigation, gardening, protection, yield predication to harvest, storing and management by virtue of remote sensing, remote surveying, remote control and computer, thus realizing the information propelling, scientific management, knowledge management, reasonable operation and high yield in the farming practice (CHENG *et al.*, 2000). Digital agriculture involves various aspects, and it roughly falls into three levels, seven components and twelve application systems, which integrate with each other (Fig. 1).

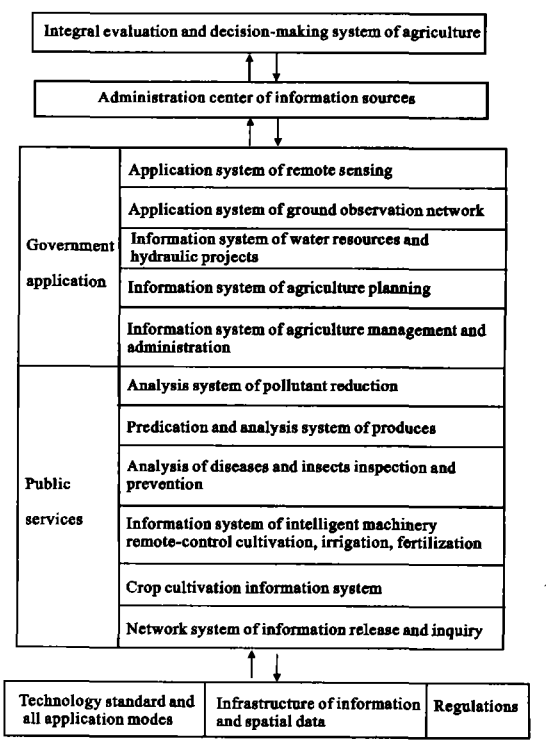

Fig. 1 Framework system of Digital Agriculture

The three levels are information basis level, integral application level and integral decision-making level. The information basis level includes public information basis platform and spatial data basis facilities, and the latter is a consistent, integral geo-spatial data and service system, including spatial data structure of digital agriculture, coordinated management of spatial data, renewing and distribution system, exchange standard of spatial data and metadata, etc. The public information basis platform includes laws, rules, regulations and technology standards. The integral application level is the professional digital structure, including government-oriented application system and public-oriented system. The integral decision-making level is a trans-regional and trans-professional integral application frame, an intelligent system founded on the basic level and the application level. The construction of a series of application models and the application of intelligent information technology will keep getting good economic and social benefits and the sustainable development of agriculture. Seven components are the infrastructure of information and spatial data, the administration center of information sources, government application, public services, the integral evaluation and decision-making system of digital agriculture, regulations, technology standard and all application modes.

Twelve application systems are the application system of ground observation network, the application system of remote sensing, integral evaluation and decision-making system of agriculture, the predication and analysis system of produces yields, the analysis system of pollutant reduction, crop cultivation information system (including field information collection), the information system of intelligent machinery remote-control cultivation, irrigation, fertilization, chemical-spraying and get-in, the analysis of disease and insects inspection and prevention, the information system of agriculture planning and its sustainable development, the information system of agriculture management and administration, the network system of information release and inquiry, the information system of water resources and hydraulic projects.

3 CONSTRUCTION CONTENT OF DIGITAL AGRICULTURE

The construction content of digital agriculture includes the informational basis construction and the development of integral application systems. The informational basis construction of digital agriculture mainly includes construction of the data bank, of Metadata standard, of ground observation network, of remote sensing system, of the GPS station, of the field collection, etc (LIANG, 2002). The development of integral application systems includes above-mentioned twelve application systems.

3.1 Construction of Data Bank

The construction of data bank is the core and basis of the realization of digital agriculture. One standard, two requirements, three types, four principles should be observed. One standard is the most important part of the construction of digital earth Metadata. The content standards of Metadata construction in other professions should be observed and data sharing and information visiting should be guaranteed in the framework of digital earth. Two requirements are the design with the principle of regularity and the object-oriented theory. Three types of the data bank include the basic data bank, the special data bank of digital agriculture and others. The basic data bank includes the data bank of basic terrain, monographic pictures, remote sensing images, and the DEM data bank etc., some of which can share with the national public data bank in accordance with the framework of digital earth. The special data bank of digital agriculture includes the data bank of standard rules, of agricultural environment quality monitoring, of crops, of agriculture statistics, of collecting fees, and etc. Other data banks include code data bank, Metadata bank, social economy statistics data bank, multi-media data bank and model data bank. Four principles are the regularity, perfection, extension and applicability.

3.2 Construction of Metadata Standard

The center of digital agriculture information network is distributed throughout China, and these centers collect and handle the information of the agricultural environments in different time and different areas by various means. The users of digital agriculture data usually cannot track down the owners, the storing forms, the quality and the reliability of the data. The promotion of data sharing needs data marking and description of the temporal-spatial features and various other attributes. The construction of digital agriculture Metadata is the most important part of the construction of digital earth metadata. In the process of practice, the content standards of Metadata construction in other professions should be observed and data sharing and information visiting should be guaranteed in the framework of digital

earth.

3.3 Construction of Ground Observing Network and Remote Sensing Monitoring System

The ground monitoring network refers to the construction of agriculture information monitoring system which is distributed evenly and specially monitor the major areas, using computer wide-band network technology to realize the prompt transmission of monitoring data from the monitoring station. The remote sensing system refers to remote sensing image monitoring system which can meet the different requirements, and it is the key to decide whether digital agriculture has vitality or not, so the 3D remote sensing monitoring system with all kinds of remote sensing platforms, resolving space powers, resolving time powers and resolving spectrum powers should be built.

3.4 Construction of GPS Station

The GPS station is used in the collection of information such as soil and seedling condition, disease, insects and weeds, and the automatic operation of intelligent machinery in the field.

3.5 Facility Construction of Information Collection in the Field

This refers to the transmission of information , such as the conditions of soil moisture, seedling, disease, insects, weeds etc., by the analysis on which users can figure out the best prescription.

3.6 Development of Application Systems

The development of application systems is above-mentioned twelve application systems.

4 MAIN TECHNICAL SUPPORT OF DIGITAL AGRICULTURE

4.1 Making Technology of Intelligent Agriculture Machinery

This machinery refers to the machines that carry out the field operation according to the experts' directions, for example, the precision seeder which can adjust the amount of wheat seeds according to the direction, automatic machines which can spread fertilizer and chemicals, water-controlling sprinkler, etc.

4.2 Real-time Collection Technology of Field Information

This refers to the sensing technology which can provide the information of soil moisture and fertility, weeds, disease, insects and seedling in time.

4.3 GPS Technology

GPS is the abbreviation of Global Positioning System. GPS is an all-weather, high-precision, global radio navigation, timing and location information service system. It is a powerful and free spatial information source for anyone at any place on the earth. In digital agriculture, GPS is used to collect information about soil, seedling, diseases, insects and weeds. On March 30, 2000, the United States declared to open the L2 channel of GPS satellite for civilian service at the press conference in White House. This will greatly improve the precision and reliability of GPS satellite service for users.

4.4 GIS Technology

GIS is the abbreviation of Geographic Information System. As a software platform used to store, analyze, treat and express geographical spatial attribute data, GIS has been mature and is used widely. In digital agriculture GIS is mainly used to set up spatial information data bank about farmland management, soil data, natural conditions, crop growth, the tendency of diseases, insects and weeds, the spatial distribution of yield etc., and carry out the geographical statistics treatment, transformation and expression of spatial information figure to provide diagnosis information for analyzing the differences and making the adjustment. It will be fitted into the crop-planting management and auxiliary decisive supporting system, together with the crop growth management and growth tendency predicting simulated model, input and output analysis simulated model and intelligent crops expert system. And under the participation of policy-makers, according to the spatial differences of output, can also analyze the reason, make diagnosis, give scientific prescription, implement the GIS farmland crops management prescription figures and guide scientific adjusting operation.

4.5 RS Technology

RS is the abbreviation of Remote Sensing. In digital agriculture, it is an important farmland data source. It

can offer a lot of changing farmland space-time information. For more than 30 years, RS technology has made great contribution to large-scale output prediction and crop macro-prediction. RS technology has been mature and is widely used. Because satellite remote sensing data has met the need of necessary spatial resolving power and real-time, it can be used to the meticulous management of crops.

4.6 Metadata Management Technology

Metadata is data of data collection and the description and explanation of data collection. It is a data-sharing system, by which the clear visit of data can be realized. Metadata in a system can improve data retrieval speed and analysis efficiency of system. In the scientific engineering practice of digital earth, through Metadata, remote data can be clearly and systematically organized. The construction and management of Metadata can promote the efficiency and even success of scientific engineering construction of digital earth.

4.7 Wide-band Computer Network Technology

Because most of the enormous data are transmitted in the network, the network should be high-speed, powerful and efficient.

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