The Main Content, Technical Support and Enforcement Strategy of Digital Agriculture

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1 Introduction

The former American vice-president Gore put forward the concept of digital earth in the speech addressed in California Science Center on January 31, 1998. The concept of "digital earth" has aroused great concern among the Chinese government, authorities and people. On June 1, 1998, President Jiang Zemin put forward the strategic conception of developing digital China. Vice-Premier Li Lanqing and the minister of Ministry of Science and Technology Xu Guanhua constantly delivered speeches on digital earth. More and more significant seminars concerning digital earth have been held in China. Many authoritative experts have been writing papers to expound this issue, and the Chinese National 863 Plan expert team has taken the idea of digital earth as a part of its developing research.

Digital agriculture is one of the most important parts of digital China and digital earth, and is the specific form of digital China. The digital agriculture, on the basis of research work and technical supporting systems, builds feasible, scattering and open information network to serve the social economic development, environment protection, research and knowledge propagation through software development and hardware integrity.

2 The purpose and significance of digital agriculture

Wang Maohua, an academician, pointed out that agriculture is the primary industry of national economy, and the guarantee of food supply and agricultural sustainable development is the never-ending theme of the world. The rapid development of world agriculture mainly depends on the technology of biological genetic breeding, the expansion of cultivated land and irrigated
area, the ever-increasing input of chemicals, and enormous input of mechanization and mineral resources. However, all these have lead to soil erosion and deterioration of ecological environment. The revolution of information technology has greatly changed the outside environment for agricultural development all over the world; international competition of products is becoming more and more intense, and policies of protectionism will be broken. Without rapid improvement of agricultural technology and productive forces, the development of agriculture and social economy will be thrown into passivity.

China is a great agricultural country. The central government has been attaching great importance to the development of agriculture. After the 3rd Plenary Session of the 15th Central Committee of CCP, the Chinese government held a meeting concerning village tasks. The Department of 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. At the meeting, some advice of promoting China's agriculture information was proposed. The Department of Technology actively organized all units concerned, and increased the expert system demonstration areas to bring along the national agriculture information. Agricultural information is the core of digital agriculture, and precision agriculture and various agricultural management information system are its important parts. The further development of digital agriculture 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. After joining in WTO, digital agriculture is a necessary and effective approach to bringing down the cost and adjusting plantation to realize water-saving agriculture, high-qualitys and high-yield pollution-free agriculture, intelligent mechanization of agriculture. From the computer network, farmers can obtain high-resolving-power satellite images 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 prevent diseases and insects in time. Obviously, it is necessary and significant to develop digital agriculture.

3 Contents of digital agriculture

The main contents of digital agriculture includes the construction of database, Metadata standard, monitoring system, forecasting and decision-making system, and information-releasing system.

3.1 The construction of database

The construction of database is the core and basis of the realization of the digital agriculture engineering. In the process of construction, not only should the design comply with the principle of regularity, integrity, extension, applicability and the object-oriented theory, but also the consistence and integrity of data should be completely guaranteed. The database includes the basic database, the special database of digital agriculture and others. The basic database includes the database of basic terrain, monographic pictures, remote sensing images, and the DEM database, and etc., some of which can share with the national public database in accordance with the framework of digital earth. The special database of digital agriculture includes the database of basic terrain, monographic pictures, remote sensing images, and the DEM database, and etc., some of which can share with the national public database in accordance with the framework of digital earth. The special database of digital agriculture includes the database of standard rules, of agricultural environment quality monitoring, of crops, of agriculture statistics, of collecting fees, and etc. Other databases include mode database, Metadata base, social economy statistics data base, multi-media database and model database.

3.2 The 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 other various attributes. The construction of digital agriculture Metadata 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.

3.3 The construction of monitoring system

The construction of monitoring system mainly includes ground monitoring 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 different requirements. And it is the key point that can decide whether digital agriculture has vitality. Thus, the 3D remote sensing monitoring system with all kinds of remote sensing platforms, space resolving powers, time resolving powers and spectrum resolving powers should be built.

3.4 The construction of forecasting and decision-making system

The forecasting and decision-making system is the ultimate goal of scientific engineering construction of digital agriculture, and is served by the construction of other systems. It mainly includes the analysis system of agriculture overall evaluation, the analysis system of crops yield forecast, the analysis system of pollutants cutting, the analysis and control system of crops cultivating, the analysis and decision-making system of insects elimination and plant diseases prevention, the decision-making system of agricultural planning and protection, the decision-making system of sustainable and economic agriculture development, etc.

3.5 The construction of information-releasing and consulting system

The information-releasing and consulting system refers to the public-serving window of the scientific engineering of digital agriculture, including part of business data, picture and image data, and multimedia data, etc.

4 The main technical support of digital agriculture

4.1 The intelligent machinery of agriculture and real-time information collecting technology

The intelligent machinery of agriculture refers to the machines working under the direction of prescription map designed by the experts, such as the accurate wheat seeders which can adjust the amount according to prescription, automatic machines to apply fertilizers or chemicals, the adjustable irrigating machines, etc. The field real-time information collecting technology refers to the sensing technology which can provide the information of the moisture content, and fertility of the soil, weeding, diseases and insects, and the growth of crops in the field.

4.2 Metadata management and fast-handling technology of remote sensing

Metadata are the data of the description and explanation of data collection. Metadata is a data-sharing system. Metadata in a system can improve data retrieval speed and analysis efficiency of the system. In the scientific engineering practice of digital agriculture, through Metadata, data in the distance can be clearly and systematically organized. The construction and management of Metadata decide the efficiency and even success of scientific engineering construction of digital agriculture. The remote sensing technology is one of the most important sources of farmland data in the scientific engineering of digital agriculture. It can offer numerous farmland spatial-temporal information. The fast-handling technology of remote sensing has yet to be worked out, so it cannot real-time provide numerous data of remote sensing image.

4.3 The technology of computer wide-band network and virtual reality

The numerous data is transmitted from the net-
work, and the network is required to be wide-band, powerful and efficient due to its large quantity of data. The construction of digital agriculture needs global stitchless connection——global or local roaming and amplifying of information, building 3D virtual reality. As a result the computer wide-band network technology and virtual reality are needed.

4.4 3S technology

In digital agriculture, GPS is used to collect information about soil, seedling, diseases, insects and weeds. GIS is mainly used to set up spatial information database about farmland management, soil data, natural conditions, crop growth, the tendency of diseases, insects and weeds, the spatial distribution of yield, etc. and to 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, according to the spatial differences of output, to analyze the reason, make diagnosis, give scientific prescription, implement the GIS farmland crops management prescription figures and guide scientific adjusting operation. RS is an important farmland data source. It can offer a lot of changing farmland spatial-temporal information. For more than 30 years, RS technology has made great contribution to large-scale output prediction and crop macro-prediction.

5 The implementation of digital agriculture

5.1 The implementation of digital agriculture in other countries

Digital agricultural scientific engineering 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% of drafting by GIS, 38% of harvesters attached to yield-surveying instruments; 61% of agriculture using yield analysis, and 90% of agriculture using 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 are 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 database system of many crop strains, such as rice, soybeans and wheat, etc. The Research Academy of New Zealand Agriculture and Husbandry provides all sorts of information services, the so-called “farm system”, the measuring of soil fertility, animal inoculation immunity, the construction of grassland and forage quality analysis. The implementation of digital agricultural scientific engineering helps their countries’ agriculture grow rapidly, increases the mechanization and the quality of products greatly, 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.

5.2 The advantages of implementing digital agriculture in China

1) There exists a social environment which needs digital agriculture badly. At present, the food supply exceeds its demand in our country, and the peasants are anxious to sell out their products. After joining in WTO, the peasants need hi-tech to bring down the cost, adjust plantation, renew products and improve the quality of crops. The peasants are eager to know what and how to grow, how to sell, and what the yield and profits are. And digital agriculture is the very solution to these problems.

2) Our country has the foundation to carry out digital agriculture. During the period of the 9th Five-year Plan, the intelligent agriculture information technology model project sponsored by the Nation-
al “863” Plan has established 20 model blocks, such as Yangling Agricultural Hi-tech Model Block. The systematic study on decision-making and information technology of experts on agriculture, the key project in the 9th Five-year Plan has integrated a lot of agricultural information, and has been connected with the internet by the domain of China Agriculture Expert Hot Line to offer public services. Another key project in the 9th five-year plan, Efficient Factory Agriculture Model Project, has developed a set of information technology and equipments needed by the facilities agriculture, which has played an important role in the increase of factory agriculture. Centered on Agriculture Information Center of China Ministry of Agriculture, the national Agriculture Information Network has been built up, and has been connected with the world net.

3) A few modern agriculture enterprises have been set up. With the establishment of social market economy, certain enterprises or returned students choose some promising and profitable agriculture projects, invest capitals into agriculture, and set up some modern agriculture enterprises. Modern agriculture enterprises are the future of global agriculture, and they are the active participants and advocates.

4) There is support from governments at different levels. China is a large agricultural country, so the development of agriculture is one of the key task of governments at different levels. Digital agriculture is the most effective means to the development of agriculture, and it will receive the support from governments at different levels.

5.3 The problems worthy of attention in the process of implementing digital agriculture

1) Make unified standard and share fruits together. Digital agriculture is a giant, continuous and systematic program. It needs to be accomplished by stages and in batches by every province and city. So a unified standard must be used when they finish their own digital programs to form a system finally and to avoid wasting and detours. The information share is the key to digital agriculture and also the restricted factor in current information industry. It needs to solve the standardization of data first and at the same time needs a suitable data-sharing policy.

2) More attention should not be paid to hardware than to software, and keep investment responsibility, benefits and interests clear, so their sustainable development can be realized. The builders should not have such illusions that information construction means buying computers, wire installation and front page release, and the money invested in software can not turn out conspicuous achievements. Management and application should not lag behind, data and systems should be renewed in time, keep benefits and investment clear.

3) Be sure to cultivate a group of new modern agriculture enterprises. Enterprises are the body of technology innovation, with strong sense of management, they actively apply new technology to pursue the utmost benefits. Digital agriculture can bring enterprises great benefits, so the agriculture enterprises will invest more capitals, which can promote the implementation of the digital agriculture.

4) Establish innovation mechanism combining production and education with researches and support outstanding major projects to promote the industrial construction of digital agriculture. The construction of agriculture industrialization must follow the route of innovation combining production and education with researches. The construction of digital agriculture needs to introduce certain nationally competitive mechanism, and cultivate and lend support to substantial and promising agriculture enterprises by the use of plural economy.

5) The implementation of digital agriculture needs wisdom, capitals, technology, organizing management and the choice of breach. Digital agriculture can be firstly carried out in certain agricultural hi-tech model blocks which have good foundations, then be carried out throughout the nation.

Digital agriculture is a giant, continuous and systematic project. To carry out digital agriculture, government organizations are supposed to set up a complete management and leading institution and technical organ composed of experts to carry out the process step by step.
5 Line simplification algorithm based on line bends

Bends are elementary units in line generalization. In Section 2, the algorithm for identifying line bends has been shown. The line generalization algorithm based on bends and that by Visvalingam-Whyatt are quite similar, but the minimal unit is a bend, and not a triangle as in the Visvalingam-Whyatt algorithm. The main principle of this algorithm is as follows:

1) Identifying all bends on the line to be generalized by the method in Section 2.4. In this process, curious phenomena could occur. It is possible that the same bend can be located on both sides of the line segment. See Points A, B, C and D in Fig. 13. If the area of a smallest bend is greater than the given area threshold, then the entire process will terminate. For example, a result of a generalized line with the bend-based algorithm can be seen as reference in Fig. 17. In Fig. 16, Point O (left-top end point) is the start point of this line, and the change of bends in the process of line generalization is shown.

2) Looking for the minimal bend which has the smallest area among all bends. This bend is then eliminated if its area is smaller than a given area threshold. In every step, the new generalized line is newly composed. And bends of this line will be identified again (Fig. 16).
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6 Analysis of the results and the future research work

The aim of the line simplification is the representation of the linear spatial knowledge on a higher level or for small-scaled maps. A line generalization with the improved D-P algorithm leads to a better result than those with the original D-P algorithm. So does that with Visvalingam-Whyatt algorithm. The algorithm for line generalization based on bends sometimes produces strange results as in Fig. 14 and Fig. 17. The algorithm based on the bend should be specially suitable for the natural cartographic linear features. In line generalization the spatial relations are an important factor, and must be absolutely considered.