Study of Intelligent Agricultural Cultivation Management Plan Model Based on Geographic Information System

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Abstract: Management plan model of agricultural planting information technology research and application of design system for agricultural production and digital has important theoretical and practical significance of agricultural planting. The study concluded, extracted the relevant agricultural planting design theory and technology research based on the show, applying the system analysis principle and mathematical modeling technique, the construction and perfection of the cropping system, ecological regionalization, precision farming and productivity of quantitative analysis of the agricultural planting management knowledge model, by using the technology of software component, with GIS as spatial information management platform, the establishment of the digital system design based on GIS and model plant. The system has realized the design of cropping system of regional cropping information standardization management and different levels of for the realization of crop planting design, quantitative and digital laid the foundation.

Keywords: Internet of things, agriculture, agricultural planting management plan, geographic information system.

1. INTRODUCTION

Agricultural cultivation management plan model reflects the management of agricultural production, processing, sales throughout the chain, the realization of all the resources of the whole chain and process management [1]. Embodies the lean production, management and agile production idea, by drawing on the concurrent engineering in industrial production and the concept of agile manufacturing, the macro implementation of synchronization of the management processes in the management of agriculture, and can quickly obtain market demand and respond to guarantee the agricultural product, high quality, implementation of lean production. Plan and control the affair beforehand thinking, prenatal, control to the agricultural industry in the production process, postpartum [2]. Reflect the thought of process management, the scientific definition and Realization of each link of planting industry management, scientific and rational organizational processes, improve efficiency, and ensure the quality of products [3].

Single narrow agricultural information, its content includes agriculture economy information, agricultural science and technology information, the information of agricultural resources, agricultural policy and agricultural related information, with the generalized social information [4]. Agricultural information covers the following aspects: agricultural production and management, the agricultural information acquisition and processing of agricultural expert system, simulation of agricultural system, decision support system for agriculture, agricultural network. Including the application of agricultural information technology in information storage and processing: computer, communication, network, multimedia, artificial intelligence. In general has network the whole process, comprehensive and other features [5, 6].

According to the characteristics of agriculture information space and dynamics, the GIS technology will be applied to agriculture information management, attribute and spatial database were established, and the attribute database and spatial database of interrelated; taking Visual Basic as the development platform, the independence of the component based software development environment, the spirit of the upgrade, convenience development of integration, explore GIS and model coupling technology, the further development of digital agriculture cropping design system based on GIS and model. System consisted with file management, map operation, information query, planting design, ecological regionalization, productivity analysis, precise management, expert consultation, system maintenance, system help and other major function.

2. RELATED THEORY AND RESEARCH STATUS

2.1. The Existing Problems in Our Country's Agricultural Production

The current production and management of agriculture in China is relatively backward, agricultural information resource sharing is poor, agricultural production process controllability, low quality, lack of agricultural products,

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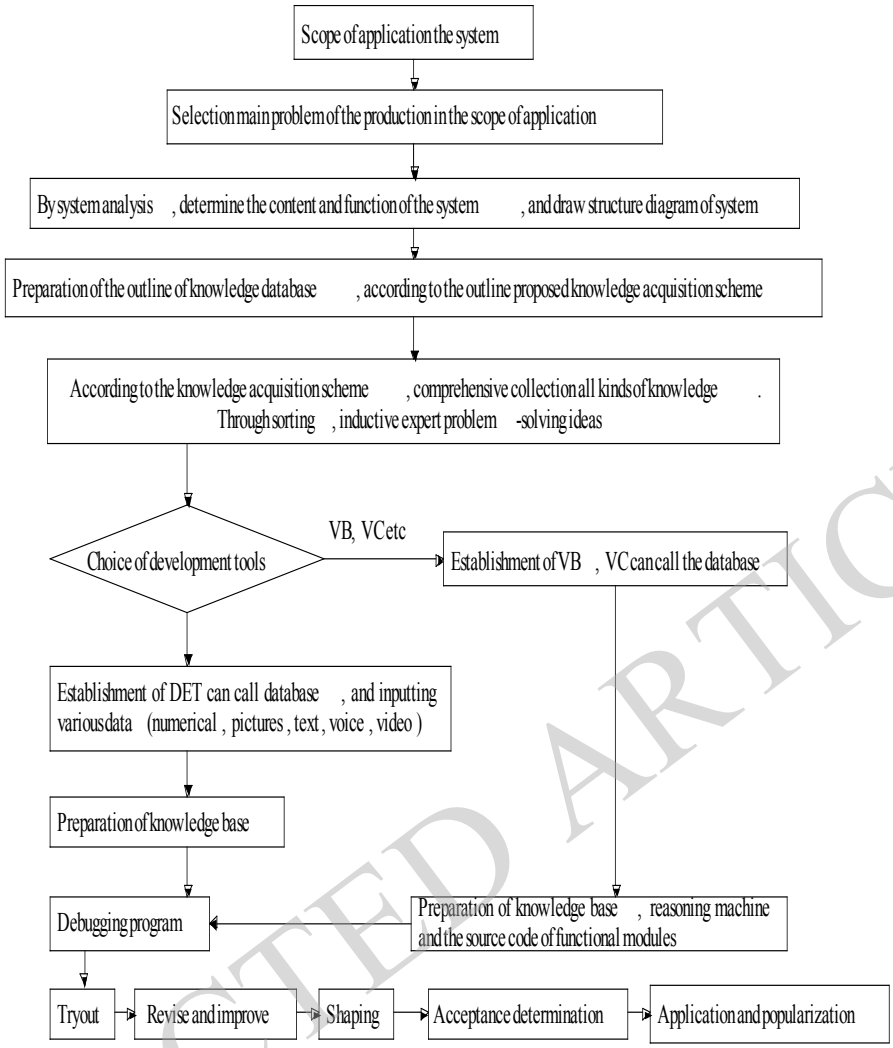

Fig. (1). The procedures and knowledge acquisition model.

agricultural products market demand peasants. Because the agricultural production and natural environment are closely linked, the fundamental way to improve agricultural productivity is the scientific production and scientific management. Because the standard production namely to agricultural product quality standards as the goal, to organize agricultural production [7].

It is an important means of organization, implementation, evaluation of the modernization of production, is the scientific management of the important content [8-10]. So the agricultural development is the inevitable trend of standardization. By drawing on the standardization management experience in industrial production, according to the production characteristics of agriculture, exploring an Internet of things technology as the core of the new planting management and mode of production - agricultural planting management plan (ACMP) model, based on information technology, network technology and agricultural production and management needs, with systematic management thought, provide a decision tool management platform for agricultural production decision layer and implementation layer, realize safety production, information management [11].

2.2. Agricultural Information Technology

Artificial intelligence research is an important aspect of information construction, and also is one of the hotspot research. Artificial intelligence is regarded as one of the century three major scientific and technological achievements, expert system and the middle of the 60's began to appear, as an application field of artificial intelligence, the research of artificial intelligence from the solid face room into the real world, the application of artificial intelligence technology is currently recognized as the most widely used and the most successful in the field. Foot l expert system is also called intelligent system, is a computer system program design method based on knowledge built up. It integrates the major achievements and experience of experts in a particular field, and can use these knowledge such as a human expert, make decisions through the simulation of human experts to solve complex problems. The basic structure of expert system is a rule based system, including knowledge base, inference engine, database, man-machine interface, to explain the procedures and knowledge acquisition (Fig. **1**).

3. AGRICULTURAL CULTIVATION MANAGEMENT PLAN MODEL

3.1. Climate Adaptability Evaluation

a) Light evaluation model

Solar radiation is the ability to source of agricultural ecological system, the amount of income and population transfer efficiency determines the level of crop colony productivity, this research according to the relationship between energy and crop growth and yield formation, choose daily radiation and percentage of sunshine as light evaluation index.

(1) Evaluation model of daily radiation

See evaluation equation of daily radiation model:

$$LSI_i = \begin{cases} 0 & (ASH_i \le CSH_i) \\ \frac{ASH_i - CSH_i}{OSH_i - CSH_i} & (CSH_i < ASH_i < OSH_i) \\ 1 & (ASH_i \ge OSH_i) \end{cases} \quad (1)$$

In the formula, LSli is the daily radiation membership values; CSHi crop critical daily radiation (MJ/m^2); the amount of solar radiation ASHi practical (MJ/m^2); OSHi is the most suitable daily radiation (MJ/m^2); i for crop growth stages, i=1,2, …, 5.

(2) The percentage of sunshine evaluation model

The percentage of sunshine evaluation model was seen equation (2):

$$RSI_i = \begin{cases} 0 & (ASR_i \le CSR_i) \\ \frac{ASR_i - CSR_i}{OSR_i - CSR_i} & (CSR_i < ASR_i < OSR_i) \\ 1 & (ASR_i \ge OSR_i) \end{cases} \quad (2)$$

In the formula, RSIi is the percentage of sunshine membership values; CSRi crop critical percentage of sunshine; ASRi for the actual percentage of sunshine; OSRi is the most suitable percentage of sunshine.

b) Temperature evaluation model

Three basis points in crop life activity process (optimum temperature, maximum temperature and minimum temperature) and temperature index make crops suffer death or together known as the five basic points of temperature on crop, according to the ecological characteristics of crops and the principle of fuzzy mathematics, can build the temperature of the membership function, see equation (3)

$$TSI_i = \begin{cases} 0 & (AT_i \le LTT_i, AT_i \ge HTT_i) \\ \frac{0.8\times(AT_i - LTT_i)}{OTLL_i - LTT_i} & (LTT_i < AT_i < OTLL_i) \\ \frac{AT_i - OTLL_i}{OTT_i - OTLL_i} + \frac{0.8\times(AT_i - OTT_i)}{OTLL_i - OTT_i} & (OTLL_i < AT_i < OTT_i) \\ 1 & (AT_i = OTT_i) \\ \frac{AT_i - OTUL_i}{OTT_i - OTUL_i} + \frac{0.8\times(AT_i - OTT_i)}{OTUL_i - OTT_i} & (OTT_i < AT_i < OTUL_i) \\ \frac{0.8\times(AT_i - HTT_i)}{OTUL_i - HTT_i} & (OTUL_i < AT_i < HTT_i) \end{cases} \quad (3)$$

c) Evaluation of precipitation model

Seasonal distribution of precipitation amount and the years of the satisfaction degree determines the length of the growing season of crops and crop water requirement, which determines the crop production and distribution. In addition, precipitation suitability, depends not only on the precipitation depends on how much and how much water at the crop, and the effective degree of precipitation and the relative rate of change. For the early crop, excessive rainfall will cause waterlogging. This research chose the characterization of total precipitation and precipitation rhythm of daily precipitation and the ten day precipitation days two factors to establish the evaluation model of precipitation.

See evaluation equation of daily precipitation model (4):

$$PSI_i = \begin{cases} 1 & (AR_i \le CR_i) \\ \frac{AR_i - ER_i}{CR_i - ER_i} & (CR_i < AR_i < ER_i) \\ 0 & (AR_i \ge ER_i) \end{cases} \quad (4)$$

In the formula, CRi is the most suitable for daily precipitation, AR_i is the actual daily precipitation (mm); ERi for wet injury lethal critical daily precipitation (mm).

d) Climate adaptability evaluation model

Indices of climate adaptability of crops is made of light, temperature, precipitation and other factors common decision, in a certain environment or some kind of creature, not all factors have the same importance. In addition, according to the law of the minimum factor, the growth of the organism is determined by the number of the missing factor. Therefore, when the membership function of a one factor is less than or equal to 0, and the comprehensive effects of other factors, also established the following climate adaptability index model (equation 5) accordingly.

$$CSI = \begin{cases} 0 & (\forall K_j \le 0, j = 1,2,...,n) \\ \sum_{j=1}^{n} K_j W_j & (\forall K_j > 0, j = 1,2,...,n) \end{cases} \quad (5)$$

Among them, CSI is the climate adaptability index; Kj index the adaptability of J evaluation indexes; Wj is the weight of the first j evaluation indexes.

3.2. Put Forward the Concept of Agricultural Planting Management Plan Model

According to the integrated management of agriculture antenatal, production, post natal needed in agricultural resources, namely agricultural production, processing, sales of integrated management system, based on computer information technology, networking technology, agricultural planting process management, follow the standardization of agricultural production requirements, a plan of agricultural planting management model, the realization of prenatal, agricultural production in producing, postpartum information, technology, materials, management of whole process management, the full realization of the rational allocation of agricultural resources.

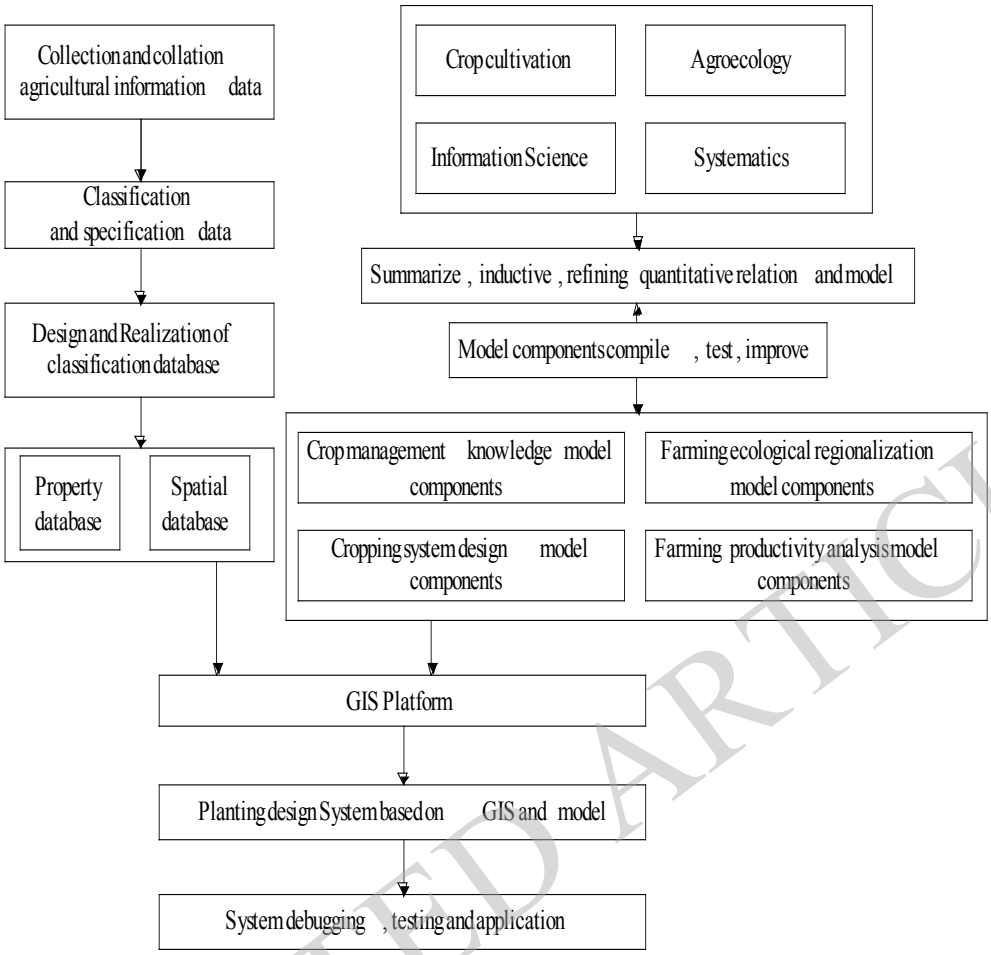

Fig. (2). The technical route.

a) Pre production

On the basis of this model based on Internet of things technology of real time acquisition of planting production data, to obtain the current has cultivated crop information, including the planting of species and have the planting area, planting area and other information, according to the mining market information analysis, planting area of soil moisture, soil testing with Fang suggestions such as the information, with the expert consultation, reasonable arrangement of planting plan, and follow the material standardization requirements, prepare the required data of agricultural production, ready for production.

b) In the process of production

On the process of agricultural production management, to ensure that the crops planted in accordance with the standard requirements, realize the whole course standard of crop production, standardized operation. The production of information can also be used to support agricultural resources survey, land suitability investigation, land utilization, agricultural regional planning, agricultural output estimation. Manage production management based mainly on planting standards on production environment factor of the acquisition, storage, monitoring, analysis, early warning and control.

c) After production

To realize information management of production obtained in the crops, transport, processing, storage and sale process. The analysis results of the crop production data, the planting area and yield of crop varieties and obtain information through the technology of the Internet of things, the macro-control of the market of agricultural products to provide data support, to provide efficient and transparent information guarantee for the trade of agricultural products, production and marketing to achieve docking, reduce agricultural risks, ensure agricultural reproduction. Data mining analysis of agricultural product market information, provide information assurance determined for agriculture antenatal work, and the formation of antenatal, production, post natal in information circulation.

3.3. The Idea of Management of Agricultural Planting Management Plan Model

According to the basic ideas of the system the research content and the research work setting, established the technical route of this study (Fig. **2**).

Table 1. Meteorological data table structure.

Number	Field Name	Unit	Data Type	Range	Default Value	Remarks
1	Country Names	—	nvarchar	—	An area	Corresponding Region fields
2	Date	—	smalldatetime	—	2000/01/01	Above field as the primary key
3	Min temperature	℃	float	[-50, 40]	0.0	—
4	Max temperature	℃	float	[-45, 45]	25.0	Max temperature> Min temperature
5	Sunshine hours	h	float	[0, 24]	6.0	—
6	Rainfall	mm	float	[0, 500]	0.0	—
7	SmID	—	int	—	1	Non-null

4. EXPERIMENTAL RESULTS

4.1. The Evaluation Factors and Factor Selection

On the basis of evaluation of agricultural environmental quality model in national standard and the selection of high toxicity, easy accumulation of crop material as the evaluation factors in the evaluation principle, selection of factors are improved, put forward the concept of key evaluation factors and optional evaluation factor, can suit one's measures to local conditions in order to properly increase the number of optional evaluation factor at the same time to determine the critical evaluation factors the evaluation, has great rationality and superiority, the evaluation results more close to the objective reality, constructs the evaluation factor set elements U:{U1, U2, U3} three single environmental factors set as shown, which underlined factor for optional evaluation factors.

$$U_{soil} = \{C_r, C_d, A_s, P_b, H_g, HCH, DDT, Ni, Cu, Zn\} \quad (6)$$

$$U_{irrigating\ water} = \{BOD, Fluoride, Hg, Cr^{6+}, Cd, Pb, As, Chloride, Total\ cyanide\} \quad (7)$$

$$U_{air} = \{SO_2, NO_x, Fluoride, TSP\} \quad (8)$$

The prediction based on the fuzzy theory, by reducing half echelon distributing method of partial small fuzzy distribution of each single evaluation factors, establish the membership degree of each class standard, the membership calculation formula is as follows:

When the quality level of j=1:

$$r_{ij} = \begin{cases} 1 & (C_i < S_{i1}) \\ (S_{i2} - C_i)/(S_{i2} - S_{i1}) & (S_{i1} \le C_i < S_{i2}) \\ 0 & (C_i > S_{i2}) \end{cases} \quad (9)$$

When the quality level of j=m:

$$r_{ij} = \begin{cases} 0 & (C_i < S_{im-1}) \\ (C_i - S_{im-1})/(S_{im} - S_{im-1}) & (S_{im-1} \le C_i < S_{im}) \\ 1 & (C_i > S_{im}) \end{cases} \quad (10)$$

When the quality level of 1<j<m:

$$r_{ij} = \begin{cases} 0 & (C_i < S_{ij-1}) \\ (C_i - S_{ij-1})/(S_{ij} - S_{ij-1}) & (S_{ij-1} \le C_i \le S_{ij}) \\ (S_{ij-1} - C_i)/(S_{ij+1} - S_{ij}) & (S_{ij} \le C_i \le S_{ij+1}) \\ 1 & (C_i > S_{ij+1}) \end{cases} \quad (11)$$

In the formula , r_{ij} for the i evaluation factor of the j grade membership, C_i for the i evaluation factor of measured value, S_{i1}, S_{i2} , S_{ij-1}, S_{ij}, S_{ij+1}, S_{im-1}, S_{im} respectively for the i evaluation factor of level *1,2 ,j-1,j,j+1,m-1,m* standard value, other by analogy.

4.2. The Development and Realization of System

The main meteorological data meteorological data tables are stored in different years throughout the year, including area SmID, name, date, the daily maximum temperature, daily minimum temperature, sunshine duration and rainfall, the table structure as shown in Table **1**:

4.3. Application and Analysis of the Instance System

Agricultural cultivation management plan model effectively save labor, technology, management cost, improve production efficiency, the management level and the quality of agricultural products; accurate environmental monitoring in production factor, improve the scientific and technological content of agricultural production process, implementation of science and technology in the agricultural production process of full penetration of informationization, industrialization of agriculture, comprehensive rural management information, the realization of green, organic agricultural production, the planting scale and industrialization of

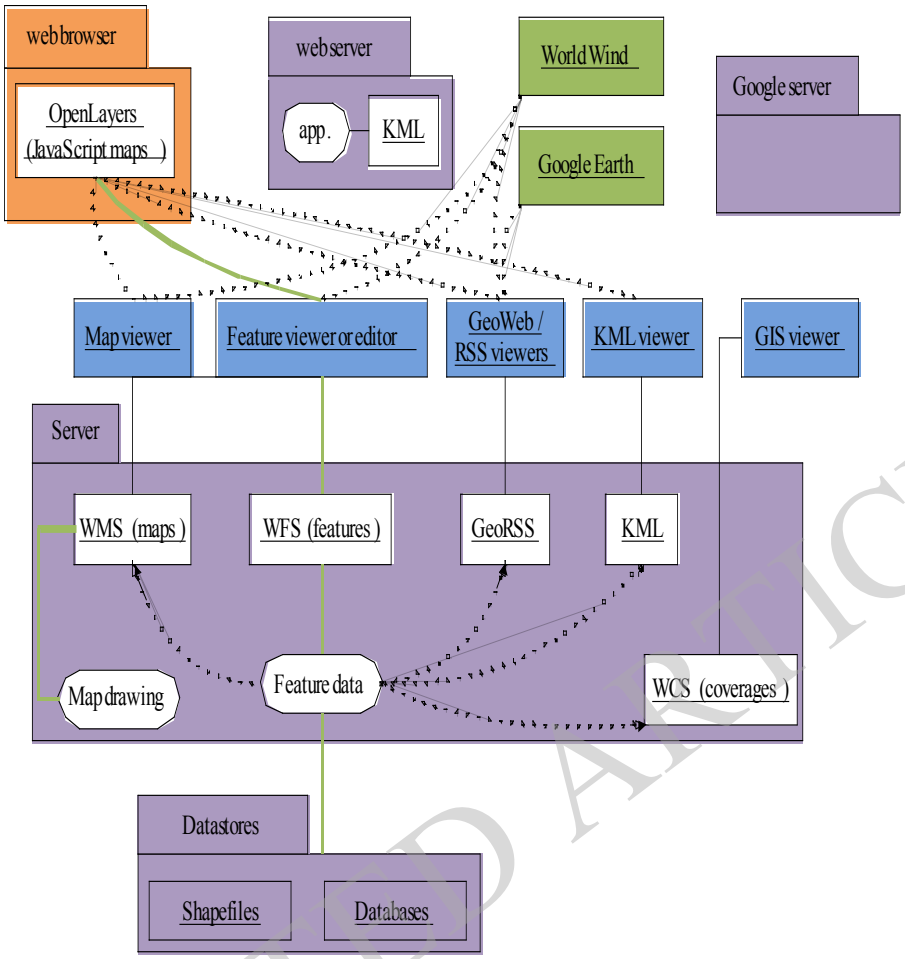

Fig. (3). The full width and Hawkeye map display function chart.

agricultural technology extension; broaden the channels and channels of communication, the realization of agricultural production guidance, such as remote diagnosis, inadequate supplement agricultural technology service; implementation of safety traceability of agricultural products; through the environmental monitoring in production, achieve the varieties of cross regional planting, enhanced weakening varieties of environmental adaptability; to crop growth conditions, growth trend, production is predicted or simulated analysis, provides the basis for the agricultural product market macro-control; promote green, organic agricultural production, planting scale and factory.

The system has realized the basic operating functions map GIS system has, including the map to enlarge, narrow, roaming, eagle eye area and distance calculation, display control, map switch. Fig. (**3**) is the full width and Hawkeye map display function chart.

CONCLUSION

Prenatal to the chain of ACMP based on Internet of things technology really realize agriculture antenatal, production, post natal in integrated management, market forecast: agricultural products, planting guide, information market of agricultural means of production; production: agricultural regionalization, the expert system to the needs of agricultural production based on information, through information technology to realize collection, storage, monitoring, warning, analysis and display, control of environmental parameters in the production process, so as to realize the guidance and control for the whole production process of planting industry; postpartum: agricultural product information and market of agricultural products, agricultural products logistics. The agricultural management, production, management and decision plays a guidance and support role. To further promote the agricultural production, agricultural resources information, precision agriculture to achieve scientific decision-making.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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