Design and implementation of planting information service system based on GIS

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Abstract. The information service of planting features various service content; scattered and isolated information; diversity of data source and format, as well as high cost of system operation. Since agricultural production decision-making and management have diversified demands on scientific and technological service, a GIS-based planting information service system was designed and developed. This system integrates the geographic information data and planting service thematic data, which is based on multi-source heterogeneous data integration, GIS spatial analysis, responsive framework and other technologies. Through various terminals such as computers and mobile phones, the system provides land circulation information inquiry, soil fertility analysis, crop variety selection, production materials purchase, agricultural technology guidance, labor employment recruitment, agricultural product sales and other comprehensive information services of the whole planting life cycle. It guides farmers to plant rationally, and helps farmers resolve the issues relating to information islands and the information shortage problem in production and life by “one-stop”, and increase the farmers' income. It can also provide decision-making gist for agricultural administrative departments to adjust planting structure, optimize the rural industrial layout and related policy formulation. Through demonstration in Zhucheng, a new model for serving “agriculture, rural areas and farmers” with surveying and mapping geographic information has been formed in terms of resource integration, geospatial data services, and service information access.

Keyword. Planting information; GIS; Space analysis

1. Introduction
China is a large agricultural country. The problems of agriculture, rural areas and farmers are fundamental to national economy and people's livelihood. General Secretary Xi Jinping proposed the implementation of the strategy of rural revitalization in the report of the 19th CPC National Congress [1]. For the implementation of “The Central Committee of the CCP, the State Council’s opinions on the implementation of the Strategy of Rejuvenating the country “, "The planning of Rural Revitalization Strategy(2018-2022) "and" Outline of national informatization development strategy", in May 2019, the General Office of the CPC Central Committee, General Office of the State Council issued the "Outline of Digital Rural Development Strategy", requiring all departments of various regions to conscientiously implement them based upon the actual situations. The outline points out: "Promote the digital transformation of agriculture, accelerate the application of cloud computing, big data, Internet of Things and artificial intelligence in agricultural production, operation and management. And promote the comprehensive and in-depth integration of the new generation of information technology
with planting industry, seed industry, animal husbandry, fishery and agricultural product processing industry. [2]

Focusing on the construction of agricultural planting information service platform, various regions have actively explored and innovated, and formed their own unique information service models, such as the “12396” WeChat system in Shandong Province [3], the Agricultural and Rural information integration service platform in Hunan Province [4], the "Yunnong 316" platform in Yunnan Province [5] and so on. But in general, the current forms and services of planting information service platforms are relatively simple, and there are still problems such as insufficient integration of information resources, asymmetry in information supply and demand, and ineffective information services. It is difficult to meet the diversified needs of agricultural production decision-making and management.

The GIS-based planting information service system aims to improve the utilization of multi-source heterogeneous data, bring geospatial data into play in agricultural planting information services, and enrich the access to service information. Facing the actual information needs in the process of agricultural planting, this intuitive and effective system integrates and processes geographic information data and planting service thematic data, integrating the application of modern information technology. The system provides farmers and relevant management departments with a "one-stop" planting information service through various terminals such as computers and mobile phones, and effectively promotes the role of surveying and mapping geographic information in serving the "Countryside, Farmers and Agriculture problems ".

2. Demand analysis
Zhucheng city, Shandong Province, is located in the southeast of Shandong Peninsula, at the intersection of the Taiyi mountain Mountains and Jiaowei Plain. The total area is 2183 square kilometers, 1.6 million acres of which is arable land. Zhucheng is a large agricultural city with a strong agricultural foundation. Main crops are food, fruits, vegetables, and tobacco. Agricultural industrialization in China originated in this city [6]. Zhucheng attaches great importance to agricultural development and accelerates the deep integration of rural primary, secondary, and tertiary industries around industrial revitalization. There is an urgent need to promote the standardization, industrialization, and intelligence of the plantation industry through information technology. Zhucheng has a good foundation of agricultural information services in the early stage, and there are abundant information and data resources related to planting services. The relevant information and data come from 15 departments including Bureau of Agricultural and Rural, Bureau of Natural Resources, Bureau of Agricultural Machinery, Bureau of Water Resources, Bureau of Science and Technology, Bureau of Economic Management, Bureau of people and Social Affairs, Bureau of Finance and so on. There are many types and huge amount of data, most of which is in the form of text, tables, and pictures, and is scattered in various departments. A few departments only built their own systems based on their own data, which are weak in statistical analysis and auxiliary decision-making. This leads to low utilization rate of information and data resources. Farmers and other departments are unable to obtain relevant information. How to comprehensively use a large number of multi-source heterogeneous data for farmers and agricultural management departments to provide intuitive and effective information services has become a major problem.

During the field survey and data acquisition process, the following problems were found in the planting information service. (1) The service content is diverse. Planting information services include...
content land circulation, soil information, agricultural material information, agricultural technology guidance, employment recruitment, planting policy, agricultural product sales and so on. (2) The information is scattered and isolated. Relevant data on planting services are distributed in Bureau of Agricultural and Rural, Bureau of Natural Resources, Bureau of Agricultural Machinery, Bureau of Water Resources, Bureau of Science and Technology, Bureau of Economic Management, Bureau of people and Social Affairs, Bureau of Finance and so on. (3) There are a variety of data sources and formats. Related data forms include the original system service interface of relevant departments, geo-spatial data, a large amount of text that has not been vectored, data tables, images, audio, video and so on.

3. Design of planting information service system
Facing the actual needs of rural revitalization and construction, focusing on the services of “agriculture, rural areas and farmers” and “industry revitalization”, based on planting information big data services, this system integrates and processes geographic information data and planting service thematic data, providing “One-stop” full life cycle information service for farmers and agricultural management departments. It provides information retrieval, statistical analysis, decision-making applications and other services on planting information spatial query analysis, soil fertility analysis, crop variety selection, production material purchase, agricultural technology guidance, labor employment recruitment, agricultural product selling, agricultural policy and regulation, agricultural product supply and demand, agricultural product market price, agricultural resources services, agriculture-related subsidies.

The overall architecture of the system is shown in Figure 1. The planting information service system is constructed on the basis of the county government cloud platform that provides the software and hardware infrastructure. Based on geographic database, the system constructs the special databases of planting information service, including planting information database, soil information database, market database, employment database and so on. The data service layer is built on the database to provide data services for the application system layer. The application system layer includes the main function modules of the planting information service system, such as the spatial query and analysis of planting information, the analysis of soil nutrient abundance and deficiency, market information and employment information, which provides support for the decision-making of agricultural management departments, planting information services for farmers and information to the public. Finally, users can access the system through computer browser and Wechat subscription.
4. Design and implementation of plant information service system function

Agricultural information services feature a wide range of objects and diverse service contents. Agricultural information is an important basis for decision-making by farmers and government workers. Since farmers have a single access to information, agricultural information system shall "weaken" the requirements of users in a limited time and space, so that users can easily and effectively obtain the most abundant information and assist users in making decisions. The system is based on multi-source heterogeneous data integration, GIS spatial analysis, response framework and other technologies. Through the integration and management of planting service data, the system designed and realized the main modules such as planting information query analysis, soil fertility abundance and shortage analysis, market information, employment information and so on.

4.1. Data integration and management

Multi-source heterogeneous data integration refers to the integration of data from different sources, qualities and formats, scattered in different places through technical means and methods to form a unified data whole, which can be coordinated for use in a unified environment[7]. Planting information service data has the characteristics of multi-type, multi-scale, multi-resolution, multi-temporal, multi-coordinate system, semantic gap and so on, which cause inconsistency and discontinuity of data. By using the method of data format conversion, geocoding technology, spatial correlation technology, GIS technology and so on, the multi-source heterogeneous data of agricultural planting information service is rapidly integrated, and the processing data is managed by mixed mode, as shown in Figure 2.
4.2. Planting information query and analysis

By integrating the planting thematic data of relevant departments, the multi-source heterogeneous data integration technology is used to form a unified spatial data, and the spatial data is further analyzed by superposition analysis and buffer analysis to realize the spatial analysis of planting information. By automatically obtaining the current location and selecting the scope of the search, farmers can easily find about production facilities information nearby, such as water conservancy facilities, agricultural capital management units, agricultural machinery cooperatives, model cooperatives, and family farms; talent information such as agricultural experts, “earth experts”, “Tian Xiucai”, employment recruitment and so on; market information such as plant subsidy policy, agricultural product supply and demand, agricultural product prices and so on, as shown in Figure 3. We will truly serve farmers through “one-click access” to comprehensive planting information, and accurately, dynamically and scientifically solve the “last mile” problem of “agriculture, rural areas and farmers” information services.
This system provides the agricultural sector management personnel with the query and analysis functions of planting types, soil types, rainfall analysis, agricultural enterprises, cooperatives, water conservancy facilities, agricultural experts, family farms, etc., as shown in Figure 4. It plays a supporting role in the adjustment of planting structure, the reform of agricultural supply side and the formulation of relevant agricultural policies.

![Figure 4. Rainfall analysis.](image)

### 4.3. Analysis of soil nutrient abundance

There are abundant soil types in Zhucheng City. The cultivated land in the city is divided into four soil groups: brown soil, cinnamon soil, fluvo-aquic soil and Shajiang black soil, ten subgroups, seventeen soil genus and seventy soil species. Soil information is mainly provided in the form of pictures, texts and forms. Soil information is difficult to obtain, and data utilization and visualization are low. The system provides land type inquiries and soil nutrient abundance analysis.

1. Inquiry of agrotype

Arable land soil of the county is vectorized and graded according to soil type, subgroup, soil genus and soil species. Soil type distribution in the county is displayed in detail. By clicking on a certain location, the user can obtain the current land soil information, including soil name, abbreviation, common name, main distribution, area, soil layer structure, soil nutrients, suitable crops, etc. This could provide basis for variety selection in planting production. Users can also search by attribute query. By entering soil type in the search bar, the system will perform a quick filtering, display the selected soil basic information in the information bar, and highlight it in the map.

2. Analysis of soil nutrient abundance and deficiency

Since the data of soil nutrient detection is point data, and the results of some detection points are missing in some years, it is difficult to reflect the effective information directly using these data. In order to solve this problem, we fill in the missing value with the possible value, which is got through multiple linear regression. According to the value or content of soil nutrients (pH value, nitrogen element, organic matter, available phosphorus, available potassium, etc.) in different years, the system uses Kriging interpolation method and takes variance chart as the weight function, and improves readability and applicability of the data though re-classification, color rendering and other processing[8][9].

The system could visually display the results of abundance analysis of soil nutrients and changes over the years. We can view the soil nutrient analysis results of a certain land from a micro-perspective by obtaining the current location or clicking a location, and we can also view the corresponding guidance given by agricultural experts. Macroscopically, the area ratio of the rich, appropriate, and lacking of various elements in soil nutrients and the overall distribution of these land within the county range can be viewed. As shown in Figure 5, agricultural managers or plant operators
can adjust the planting structure and optimize the industrial layout based on the results of soil nutrient abundance analysis.

![Abundance analysis of soil nutrients](image)

**Figure 5. Abundance analysis of soil nutrients**

4.4. Market information
Growers can publish the product information that they plan to buy and sell though this module, which provides a network platform for communication between buyers and sellers, so as to expand the market through the network. The supply and demand information can be retrieved simultaneously in the planting information module according to the obtained location. In order to facilitate the operation of farmers, the information only needs to be checked and selected simply. Qilu Rural Property Rights Trading Center supply information for this system. So users can obtain the land transfer information. At the same time, the system provides users with the prices of vegetables, non-staple foods, raw grains, edible oil, fruits and refined grains in Longcheng market and Baisheng supermarket, and green seedling market prices, as well as agricultural production material prices and other information. It facilitates users to know the latest market price information while staying at home.

4.5. Employment information
According to the needs of farmers in the actual production, the system aims to solve the problems of employment in the surrounding production parks and alleviate the "labor shortage" in rural busy season. The employment information part is linked to two recruitment websites of Zhucheng City, which are "Zhucheng talent recruitment website" and "Zhucheng Huibo talent website", respectively. The system also sets up local employment recruitment and employment functions for farmers and peasant households, who can simply check and drop down the options to meet their needs. According to the survey, the types of employment are mainly divided into planting, animal husbandry, agricultural machinery, sightseeing agriculture and facility agriculture. The job application and recruitment information, which consists of recruitment position, education background, work place and salary, is displayed in the form of a list. Users can select recruitment information according to recruitment position type, required gender, age and education background.

5. Conclusion
The planting information service system based on GIS starts from solving the most concerned, direct and realistic problems of farmers, integrates geographic data and special data of planting, and provides farmers with information services related to agricultural crops from planting to harvest and information related to their daily life with the help of the internet and Wechat, so that farmers can look for the help of experts, understand the market, buy agricultural materials and enjoy services without the need of leaving their home, which can make their production process more efficient, their life more convenient, and truly realize "No worry about revitalization with one machine in hand".
Simultaneously, it can query and analyze the spatial layout of plant type, soil type, state of soil nutrient, rainfall, agricultural enterprises, cooperatives, water conservancy facilities, agricultural experts, family farms of agricultural management departments, which plays an auxiliary role in decision-making for the adjustment of planting structure, reform of supply side of agriculture and the formulation of relevant agricultural policies so as to solve the problem of "the first kilometer" and "the last kilometer" in agricultural services.

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