Application of Remote Sensing Technology in Agriculture of the USA

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Abstract. With the development both of the information technology and the aeronautics and astronautics technologies, the remote sensing technology has been used in agriculture widely and deeply. After completing the "Agriculture and Resources Inventory Surveys through Aerospace Remote Sensing" plan, remote sensing technology was widely used in agricultural sectors in the USA. Such as the planting area, yield estimation, crop spatial distribution, agricultural insurance, agricultural disaster monitoring, protection of agricultural environment, etc. And meanwhile built a basic database of agricultural remote sensing, based on the data of "Common Land Unit" CLU） and the "Cropland Data Layer" (CDL). The author went to America to visit some officers, professors and specialists, in order to learn the developing situation of remote sensing technology application in agriculture in America. Through communicating and discussing, he got a lot of information and materials and produced some thinking. This paper expounds the present situation of the development of American agricultural remote sensing from data sources, basic data platform and application of remote sensing technology, etc. At the same time, analyze the base about remote sensing technology used widely in American agriculture from based data storage, data sharing mechanism, operation and business system, the degree of automation, etc. Finally, the paper mentioned three points for discussion on the development direction of Chinese agricultural remote sensing. First, strengthen the concepts of universal, sharing, integration of remote sensing technology. Second, lay stress on the goals of guiding production, managing resource, servicing decision by remote sensing technology. Third, grasp the keys of basic data studying, data platform building, technologies advance.

Keywords. Agriculture, Remote Sensing Technology, Application, Development

Communication, discussion and study is a important method to understand the development of science and technology of the world. We went to America to visit some officers, professors and specialists for learning the developing situation of remote sensing technology application in agriculture of America. It worth learning and using for reference about complete basic data platform and running system, and so on.

Agriculture development main met the market competition of domastic in the past,but now it is paticipating in the market competition from domastic and international. And agriculture technology development will have the newer and higher requirements. [1]The aeronautics and astronautics technologies promoted the development of the technology for earth observation of human and the studying and business application of remote sensing technology. [2]Understanding and mastering the situation of agriculture accurately and timely by agricultural remote sensing technology, which is one of the new sectors of agricultural high technology industrialization at present. [3] The Chinese Ministry of Agriculture Remote Sensing Application Center had been carried on crop monitoring business since 1998, has supplied many a lot of agricultural information to the government for making policy decision of agricultural production. And gain the huge economic and social benefits. [4] However, it is worth attention that some gaps exist in the agricultural remote sensing application, which include the data base preparation , the technology widely useing and the business running system etc, compared with America ‘s. America's experience is worth learning and using for reference in out country.

In the early 1960 s, the agricultural remote sensing laboratory of Prudue University carried out crop acreage monitoring with remote sensing data firstly. It proved that remote sensing data could be used to monitor crops, on the basis of the successful experiments of the corn monitoring. [5] To carry out agricultural monitoring in the large-scale, used remote sensing technology,by American Agriculture

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ministry from the plan of “Large Area Crop Inventory and Experiment” in the 1970 s and the plan of “Agriculture and Resources Inventory Suveys Through Aerospace Remote Sensing” in 1980 s.[6]
The two plans identified corps, measured area, estimated yield, uitilized satellite images. And they completed the growth situation assessment and production forecast for kinds of food crops in America and different regions of the world. Then, the remote sensing technology was used widely in agricultural industry. Such as Crop area statistics, crop yield estimation and crop spatial distribution of cartography, agricultural insurance, disaster monitoring, agricultural subsidies, agricultural environment protection, etc.

1 The data resources in the America agriculture remote sensing monitoring

A lot of data resources are used for America agriculture remote sensing monitoring. The first is aerial image, which is updated in every two or three years by Farm Service Agency. The second is satellite image, which is obtained from satellites of America, such as LantSat and Modis and so on . The third is satellite image, which is obtained from satellites of other countries, such as Spot, IRS, DMC, RapidEye, etc. The remote sensing images can cover the United States and the main agricultural regions of global about five to six times in one year, except aerial image. The plenty of remote sensing data and products provides a strong support to agricultural production management and service in the United States.

2 Two important fundamental spatial data to support agricultural remote sensing business running work

The United States Department of Agriculture has established the special agricultural remote sensing database to meet the requirements of agricultural remote sensing monitoring business running work. Both the “Common Land Unit” and the “Cropland Data Layer” are very important data, have been widely used in lots kinds of agricultural remote sensing monitoring works. And they are the bases to agricultural remote sensing application in the special database.

2.1 The data of Common Land Unit (CLU)

America carry out aerial photography every two or three years. And use the aerial images cover all homeland of the USA. Using fences, rivers, roads and other permanent features to divide the agricultural land plot and other land to make CLU with the main way of computer automatic classification, while combining the method of artificial visual interpretation. Then give each plot a unique number. At the same time, according to multi channel informations coming from farmers' reports and ground survey,etc to correct it.

2.2 The data of Cropland Data Layer (CDL)

The USA had drawn the CDL from 2010, covered 48 states and included more than one hundred kinds of crops. The relevant department published data and carried out the information services work through sharing platform. CDL combine CLU may raplace the triditional way of the ground quadrat investigation to achieve a new leap forward.The remote sensing monitoring of crop spatial distribution has been changed from the typical sample survey to full coverage survey and the results has been changed from figure to map. It laid a solid foundation for computer automatic interpretation and let the USA became the first country to carry out the business running work of crop spatial distribution drawing of whole nation, and has produced a great influence in the field of international remote sensing.

Mading CDL based on the data of CLU and June Agricultural Survey and ground quadrat investigation,etc. Utilize the intermediate and high resolution remote sensing data and selecte special

land plot, which only planted one crop, as training samples of supervised classification method to identify and divide the different types of agricultural land. In the process, the number of training samples of every kind of crops is more than fifty per cent. It could ensure that the supervised classification accuracy is above ninety percent. In addition, in America,law supervision system is perfect, institutional setting is direct and effective, staff is stabile, professional quality is good, which are the keys to ensure the precision of training samples.

3 The application of remote sensing technology in America agriculture

3.1 The application of remote sensing technology in agricultural investigation

Basing on the data of CLU and depending on the tool of Geography Information System (GIS), lay the irregular sampling grids, whose area about 3—4 square miles，then superpose this data layer and the remote sensing images covered the whole country and the CDL to judge the crop’s varieties and area in the grid. According to the acreage ratio of crop’s variety in grid, with the method of area sampling as the basic sampling frame, merge the same types of grids to the six levels of different ranges. According to a certain proportion of the grid sampling to determine the investigation numbers of each layer. The soft of GIS can help to show the position of grids of each level. On this basis, investigate and verify the samples of agricultural information, and carries on the analysis using the extrapolation model, so as to obtain the national agricultural situation.

3.2 The application of remote sensing technology in agricultural insurance

Establish the complete agricultural information database with the data of CLU, CDL, soil information, meteorological information, agricultural intrduction information, and so on. On the one hand, use GIS and many kinds of remote sensing images to monitor the Crop cultivation situation and land plot position, to measure land plot area, and to identify the kinds of crop. In order to judge the authenticity of the insurance investment. On the other hand, after knowing that the occurrence of disasters in some regions, use Normalized Difference Vegetation Index (NDVI), getting from remote sensing data, to analyze the crop growth situation. Estimate the degree of disaster losses through comparing with the many years average case of crop growth situation. Combinning with the information of Crop growth period and occurrence time of disaster, judge the situation of crop replant and recovery. Provide the basis for the rapid estimation of insurance amount.

3.3 The application of remote sensing technology in Flood disaster monitoring

Analyzing and comparing multi-temporal satellite images combining with meteorological information to get the spatial disribution situation of water , such as rivers and lakes, in nomal years and to measure the area of the water from images. After learning that the occurrence of flood disaster in some regions, superimposed the latest remote sensing images and the water spatial distribution vector data production to monitor the influence scope of the flood disaster. Remote sensing technology can monitor scope of agricultural land flooded, but it unable to probe the deepth of water and to determine whether the formation of flood disaster.

3.4 The application of remote sensing technology in drought monitoring and its early warning

3.4.1 The application in drought monitoring

Different reagions have different mean annual precipitation, soil condition and vegetation growth condition, etc. Depend on data of NDVI, meteorological, CDL and CLU to divide some regions with some same attributes. According to the actual situation of the region, fomulate the drought judgement index standard and the corresponding levels of drought. Calculate the regional drought index with data of NDVI, basing on some models. Such as growth model, meteorological model, remote sensing model,

etc.

3.4.2 The application in drought early warning

Monitoring temperature of soil and land surface with thermal infrared band of MODIS, high time resolution data, every day. Combining with the data of CDL and CLU, culculate vegetation evapotranspiration in a plot. Wet soil is low soil temperature and large vegetation evapotranspiration. And drought soil is high temperature and small vegetation evapotranspiration. According to the drought judgement index standard and the corresponding levels of drought warn drought occurred early. Improve the spatial resolution through fusing the data of TM to improve the accuracy of monitoring in small scale.

3.5 The application of remote sensing technology in groundwater pollution monitoring

Early stage field data were gained with a limited number of ground monitoring stations. Calculated the region's situation from some points to the surface by interpolation method, which would formate some mistakes. Nowadays, through monitoring temperature of soil and land surface with thermal infrared band of MODIS, combining with CDL and CLU to identify the kinds of vegetation and the spatial distrabution, calculate vegetation evapotranspiration in the polt. Contrast the nearest grassland, has the same attributes and no irrigation, to judge the situation of irrigation of agricultural land. Calculate the water consumption, infiltrate into groundwater, with the vegetation evapotranspiration and the irrigation water capacity recorded by water-meter. Finally, get the data of the total amount of pesticide, fertilizer and other substances into the groundwater. Provide the basis for groundwater pollution control and governance.

3.6 The application of remote sensing technology in land farming intensity monitoring

Collect soil spectral information, crop residue (straw) spectral information and other field information by spectrometer to establish interpretation signs information database of remote sensing image, combining with the data of CLU and CDL to identify the kinds of the crop of specific plot. Distinguish and exstract area of residure with satellite images for calculating the area percentage about specific plot and the crop residue in it. In order to monitor the land farming intensity and to provide the fundamental data for protecting farmland.

3.7 Summary

There are two prominent features in application of remote sensing technology in agriculturae of the USA. The first is to establish a big data platform. Ultilizing a variety of productions of spatial fundamental data, including CDL and CLU and other important data, and combining with other many kinds of data, such as meteorological, hydrology, soil, agricultural production, etc, build a agricultural remote sensing plotform of resource and environment for servicing agricultural production and management. The second is to exploit a variety of models. Exploit and optimize mathematical models pertinently for different application purposes based on big data. A series of remote sensing models, such as corp growth model, vegetation evapotranspiration model, agricultural drought model, meteorological model, agricultural environment evaluation model, and so on, is important tool for broadening the scope of application of remote sensing technology.

4 The fundament for wide application of agricultural remote sensing technology in the USA

4.1 A solid foundation of American agricultural remote sensing data

Application of agricultural remote sensing need strong support with lots of data and information to suppost. Especially the CLU and the CDL are necessary and the foundation of basic data for this

business. According to these, America achieved standardization and automation to data processing and applied remote sensing technology widely to many fields of agriculture. A lot of intermediate and high resolution remote sensing data covered whole country for five to six times in a year and aerial photography data covered all the land for one time every two years. A plenty of remote sensing image data ensure remote sensing products' accuracy and timing.

4.2 There is an open data sharing platform in America

Different departement in United States Department of Agriculture (USDA) are responsible to different part of agricultural remote sensing monitoring data. Such as the CLU is produced and managed by Farm Service Agency (FSA), and the CDL is produced and managed by National Agricultural Statistics Service (NASS), and so on. These data are public and shared in the USDA, through an open data sharing platform. The platform makes it possible to talk with data, to formulate agricultural policy with data and to serve with data.

4.3 Agricultural remote sensing running system is complete in America

On the one hand of institutional settings, NASS had special remote sensing institution of themselves and developed complete and vertical management work system. It owns independent offices in state and county and both agricultural statistics personnel and ground investigation personnel in it. The staff is stable and specialized. They can operate relevant business softs skillfully and submit results timely, according to the working process. On the other hand of working mechanism, the USDA assigns remote sensing monitoring job and researches of remote sensing application technology to agricultural offices in state and county or entrusts them to the research institutes and universities through the way of government buying products and services. These final results will be shared by the big data platform of USDA.

4.4 There is high degree of automation to agricultural remote sensing image interpretation in the USA

Agricultural remote sensing data is complete, open, high degree of standardization in America. Remote sensing image interpretation and information extraction have been achieved intelligentialize and automation. Reasonable institutional settings improve the ability of getting ground investigation data greatly. Stronger coordination ability of spaceflight, aviation and ground monitoring can update the basic information database quickly and provide security for increasing the level of automation of agricultural remote sensing technology.

5 Discussion

Agricultural modernization need modern management technologies. Facing the age of big data, American experience of agricultural remote sensing is benefit to accelerate the business of Chinese agricultural remote sensing and to consolidate the supporting role of agricultural remote sensing. In order to supply stable and reliable services to the level of agricultural modernization upgrade.

5.1 Strengthen the idea of universal suitable for use, sharing and cooperation

Building the idea of data sharing steadily , promoting the creation of big data platform rapidly, enhancing the cooperation of the agricultural remote sensing and agricultural statistics investigation and other ways effectively, are the key to improve the quility of agricultural products.

5.2 Highlighting the targets of guiding production, managing resource and serving policy decision

Monitoring the relevant information of crop cultivation and growth, disasters and meterological to guide agricultural production in different regions and to enhance the ability of disaster prevention and mitigation. Monitoring and investigating Cultivated land, grassland, water area and ecological environment, etc to carry out the agricultural resource management and environmental capacity

evaluation and to provide the foundation and basis for promoting agricultural sustainable development. Depend on the important basis of agricultural remte sensing data to promote the integration of depth of remote sensing technology and modern agriculture and to realize scientific management.

5.3 Grasp well the priorities of the basic data preparation, the data platform building and the key technologies studying

To start from the food crops, achieve synchronous mapping and annual data updating of a variety of crop. Integrate the data of agricultural remote sensing, agricultural resource and agricultural production to exploit and apply the service function of big data platform effectively. Broaden the fiele and scope of the application of agricultural remote sensing. Give impetus to the research and innovation of technology and method. Speed up the transformation and the application of the results.

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