Remote Sensing Monitoring Operation System for Agriculture

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Abstract: The research and application of remote sensing technology in agriculture started in late 1970s in China. Over past 30 years of development and on the basis of technical introduction, R&D, the remote sensing technology in the Chinese Ministry of Agriculture has become one of elementary means in monitoring growth of main crops, production prediction and soil moisture content etc. The general objectives of remote sensing monitoring system in the Ministry of Agriculture are to establish a dynamic monitoring system covering the whole country, with complete system, combination of remote sensing with ground and stable operation. The focus is on constructions of systems of conducting main crop remote sensing monitoring, agricultural resource monitoring, and demonstration of digital and fine agriculture in terms of monitoring. This paper is to present existing status of remote sensing monitoring operation system of Remote Sensing Application Center of the Ministry of Agriculture, including major contents of remote sensing monitoring, adoption of key technology and framework of operation system and outlook for further development.

1. Major Contents of Remote Sensing Monitoring

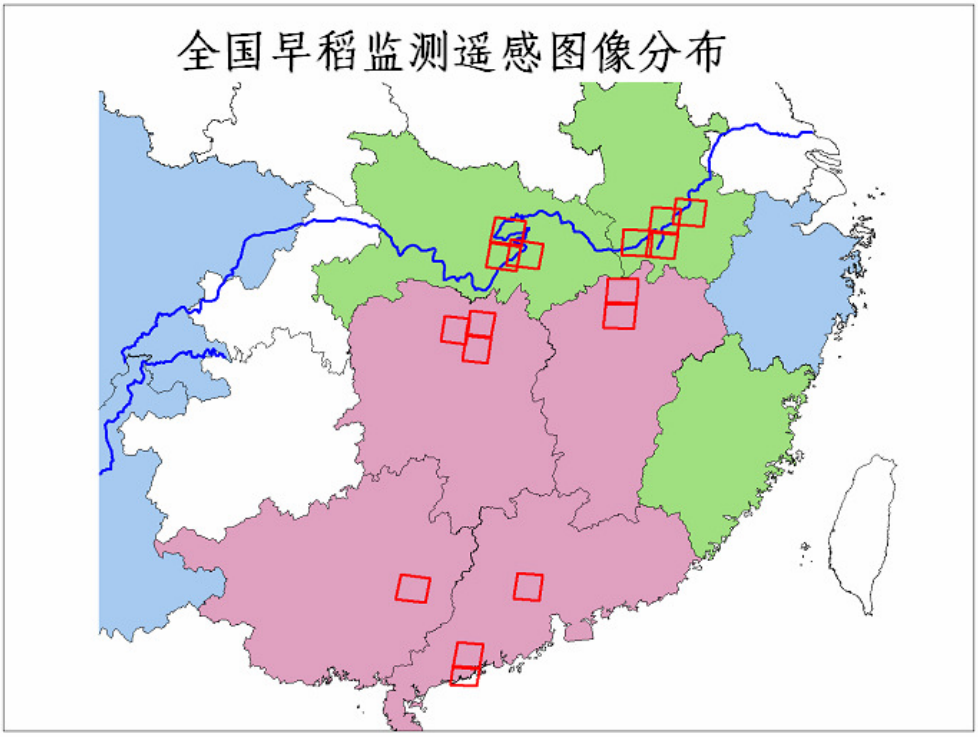
1.1 Remote Sensing Monitoring for Main Crops

Since 1999, Remote Sensing Application Center of the Ministry of Agriculture worked on continuously remote sensing monitoring on the main crops in the whole country for 8 years, the monitoring targets including 5 main crops, namely, rice, wheat, corn, soybean and cotton and monitoring content covering planting area, growth, disaster and production etc., among which, monitoring on sown area completed one month before harvest; monitoring on soil moisture content and growth conducted once every two weeks; monitoring on production once every month in late stage of growth; and dynamic monitoring and assessment done on major agricultural natural disasters of dry and flooding etc. based on the occurrence of disaster.

1.1.1 Planting Area Monitoring. The area monitoring mainly adopted the commercial satellite data of Landsat, TM, SPOT, CBERS, IRS and P6 etc., with monitoring scale of covering main production zones.

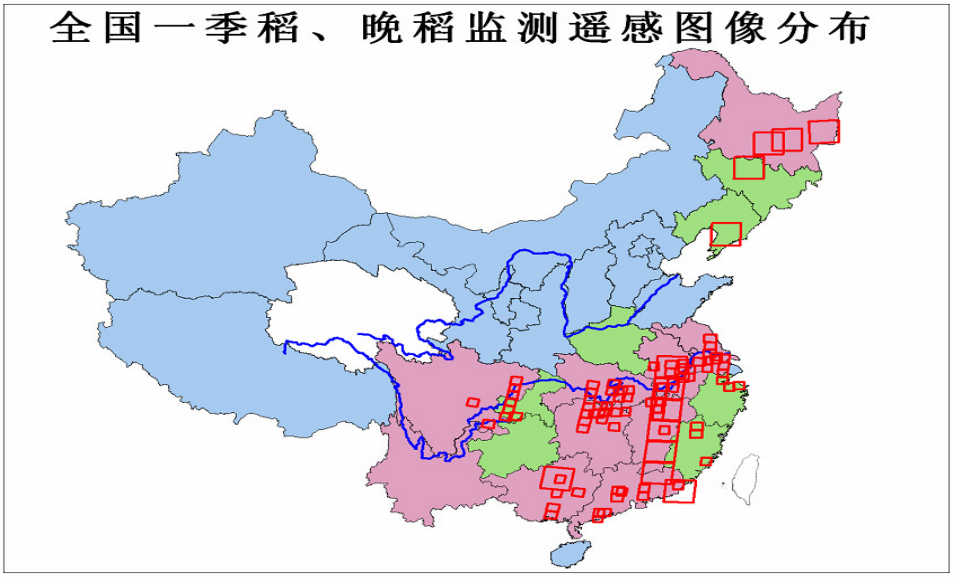
1.1.1.1 Paddy Rice Monitoring. The monitoring on rice planting area in the whole country includes early-mature, one-crop and late-mature rice. The monitoring zones for early-mature rice are located in 6 main production provinces, i.e. Hunan, Jiangxi, Guangdong, Guangxi, Anhui and Hubei. The locations of remote sensing monitoring

zones show below:



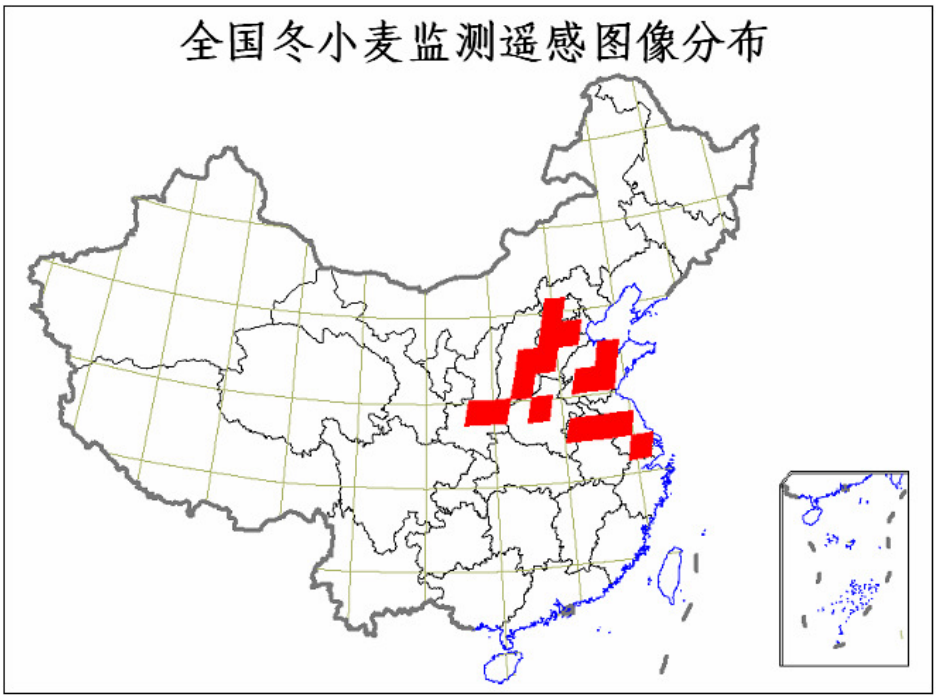
National Distribution of Early Paddy Rice Monitored by Remote Sensing

The monitoring zones of one-crop and late-mature are in 14 provinces and cities, i.e. Hunan, Hubei, Jiangxi, Anhui, Jiangsu, , Zhejiang, Guangdong, Guangxi, Fujian, Sichuan, Chongqing, Heilongjiang, Jilin and Liaoning. The locations of remote sensing monitoring zones show below:



National Distribution of One-crop and Late Paddy Rice Monitored by Remote Sensing

1.1.1.2 Winter-wheat Monitoring. The monitoring zones of winter wheat mainly are in major winter wheat production areas of Yellow River, Huaihe River and Haihe River regions, including provinces of Hebei, Henan, Shandong, Shaanxi, Shanxi, Anhui and Jiansu, etc.. The locations of remote sensing monitoring zones show below:

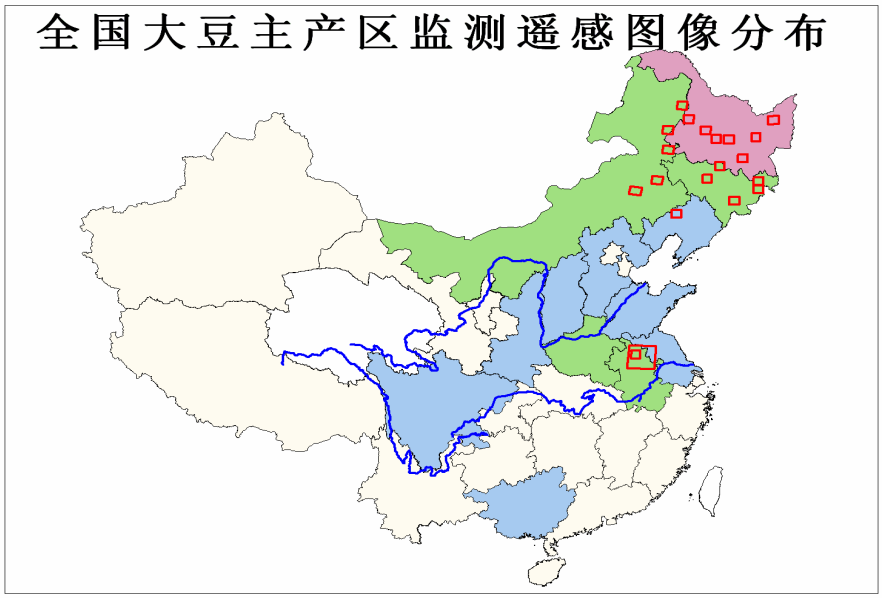


National Distribution of Winter Wheat Monitored by Remote Sensing

1.1.1.3 Corn Monitoring. The monitoring zones of corn are in main corn production zones of Northeast and Yellow River, Huaihe River and Haihe River regions, i.e. Heilongjiang, Jilin, Liaoning, Hebei, Henan, Shandong, Shaanxi, Shanxi and Anhui provinces, etc. The locations of remote sensing monitoring zone show below:

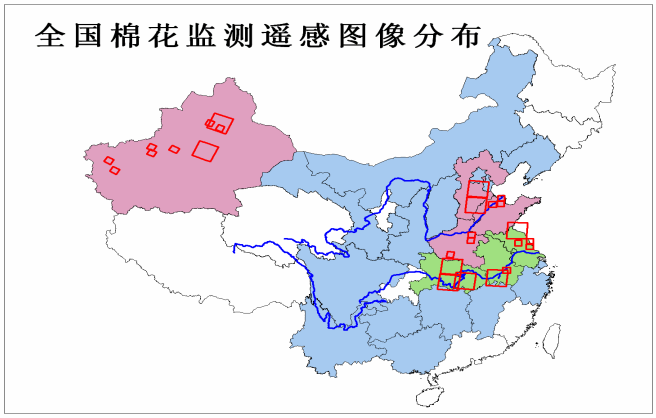
National Distribution of Corn Monitored by Remote Sensing

1.1.1.4 Soybean Monitoring. The monitoring zones on soybean mainly are in North-east production areas of Heilongjiang, Jilin, Liaoning, Eastern part of Inner Mongolia, Northern Huaihe River region of Anhui province as concentrated production zones of Yellow River, Huaihe River and Haihe River regions. The locations of remote sensing monitoring zones show below.



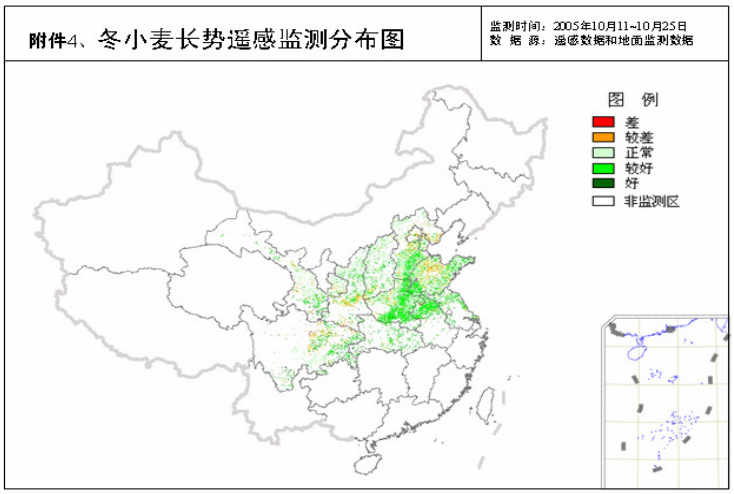
National Distribution of Main Soybean Production Areas Monitored by Remote Sensing

1.1.1.5 Cotton Monitoring. The monitoring zones on cotton are mainly are in three key production zones of North-west, Yellow River, Huaihe River and Haihe River regions and mid- and low-reaches of Yangtze River, i.e. Xinjiang, Hebei, Henan, Shandong, Jiangsu, Anhui, Jiangxi and Hubei provinces and autonomous regions. The location of remote sensing monitoring zones show below:



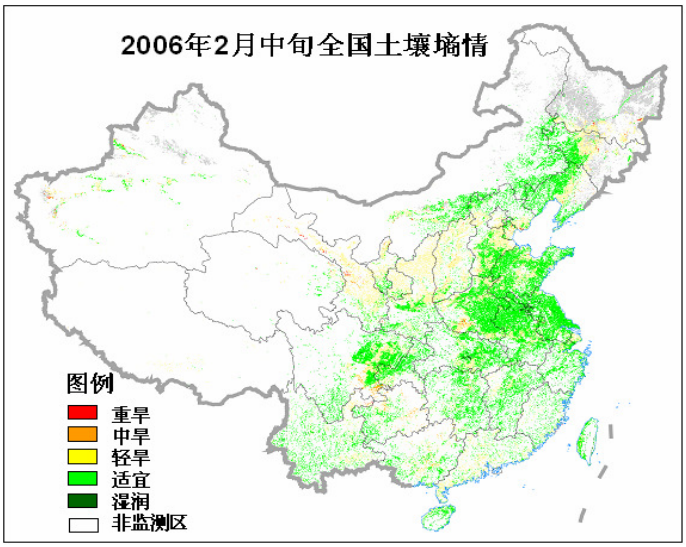
National Distribution of Cotton Monitored by Remote Sensing

1.1.2 Crop Growth Monitoring. The monitoring of crop growth adopted climatic satellite data of MODIS, NOAA and FY etc., in combination with ground survey. The monitoring and assessment on crop growth show below in comparison with results for two years.



National Image of Winter-wheat Growth Conditions Monitored by Remote Sensing

1.1.3 Monitoring and Assessment of Natural Disasters in Agriculture. The monitoring and assessment on soil moisture content and dry disaster are conducted on the basis of remote sensing model of index of vegetation water supply, soil thermo inertia quantity, anomaly vegetation, etc, combined with climatic observation data of normal precipitation and ground survey and proofing.



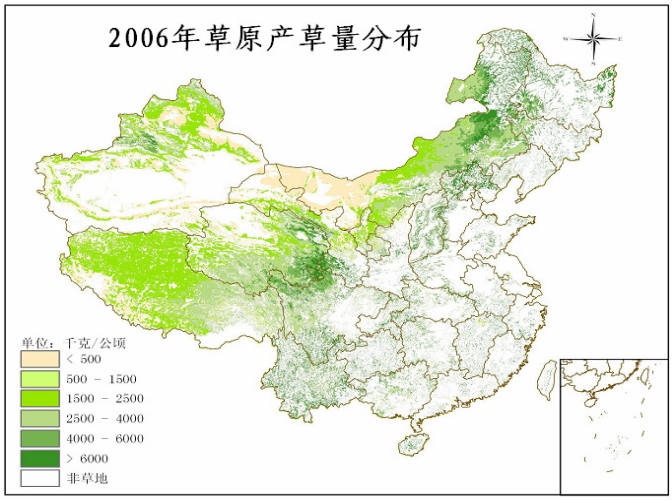
National Soil Moisture Situation Mid Feb. 2006

1.1.4. Crop Production Monitoring. The monitoring on main crop production adopts integrative estimation of production by model of agricultural climate, remote sensing and growth and combines monitoring results of crop growth and information of ground survey.

1.2 Remote Sensing Monitoring on Agricultural Resource.

1.2.1 Monitoring of Changes of Regional Agricultural Land by Remote Sensing. The comparison monitoring method of two time remote sensing images coverage is applied to carry out remote sensing monitoring of agricultural used land change early and later in the regions of Northeast, Beijing, Tianjin, Hebei reaches of Yellow River, Huaihe River and Haihe River and to obtain data on decade changes of cultivated land, grassland, garden, water area and unused land for providing fundamental information for agricultural planning, structure adjustment and regional overall arrangement.

1.2.2 Grassland Resource Monitoring by Remote Sensing. The method combining the remote sensing with ground monitoring is used to implement the remote sensing monitoring on grass growth, production on grassland and grass-animal balance in grazing and semi-grazing lands.



Distribution of Grass Yielding in 2006

1.3 Ground Monitoring Network

Year 2005 saw 100 national ground monitoring network counties in main farming regions of the country in order to further update accuracy and reliability of remote sensing monitoring system, executing ground monitoring on soil moisture, crop growth and production to support and confirm the remote sensing monitoring by ground data.

2. Technical Methodology

The Agricultural Remote Sensing Operation System adopts the following key technologies, based on information technology of remote sensing, GIS, GPS and

Internet etc. and taken remote sensing technology combined with ground survey as a basic monitoring means:

2.1 Cropping Area Monitoring. The technology of remote sensing statistics is applied to monitor annual changes of crop planting acreages. First, sampling frame is designed by stratified sampling methodology according to distribution of cropping zones; second, drawing samples of annual changes of cropping areas units by remote sensing images; and finally, the national annual change is calculated by Richardson model. Ground sample square should be laid to supplement and support the remote sensing monitoring at the same time of remote sensing monitoring.

2.2 Crop Growth Monitoring. The relative sound correlation of NDVI, leave area index, biomass and content of chlorophyll is elementary indication factor for crop growth. The monitoring on crop growth adopted NDVI as parameter is used to calculate NDVI value of crops for two years in the neighboring area to the same monitored zone, and error value that is divided into grades, this monitoring the sound or worse growth of crops in different year in the same region. The comparison of current NDVI with past years NDVI in the same period is utilized for preparation of standards of grading.

2.3 Monitoring and Assessment of Natural Disasters in Agriculture. The Monitoring and assessment on natural disaster in agriculture contains monitoring on soil moisture content and dry and flooding disasters. The monitoring on soil moisture content and dry disaster is used with thermal inertia and vegetation water supply, combined with date of ground actual survey of soil moisture, to establish monitoring model of soil moisture and assess dry situation on the basis of type of crops and periods of growing and development. The monitoring on flooding disaster is applied with climatic satellite image to obtain information on scale of flood and logging and time etc, and disaster statistics and loss assessment are conducted by integration with GPS and monitoring on crop growth.

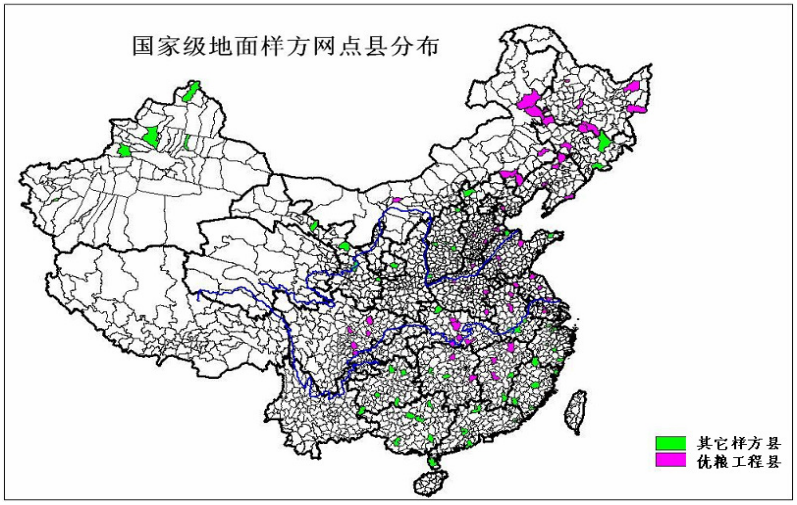
2.4 Crop Production Monitoring. Due to complex of production monitoring, the remote sensing operation system adopts integrative monitoring on production. The integrative analysis of production is worked out by production monitoring model, crop growth, results of disaster monitoring and information on ground survey, among which, the crop growth model including agricultural climatic model, remote sensing model and crop growth model etc.

3. Operation System

The remote sensing monitoring system of the Ministry of Agriculture is composted of two parts, i.e. remote sensing and ground network. The organization system of unified leadership, work division and coordination is shaped up on the basis of 7 regional sub-centers in the area of remote sensing monitoring. At present, there is a specialized technical group composed of over 200 persons, equipped with appropriate equipment

and capacity of working on remote sensing monitoring on crops, agricultural resource, natural disaster and service. In terms of ground network, the arrangement of 100 national monitoring network counties launched in 2005 in China, all network point equipped with computer, ground survey equipment and database software etc., regular train conducted on monitoring technology to primarily form a team of ground monitoring. The Remote Sensing Operation Center of the Ministry of Agriculture has set up a relative efficient operation mechanism, through combination of remote sensing monitoring with ground network, to realize the automatic integration of work at central and local levels and to provide improve of agricultural remote sensing application with high efficient organization guarantee.

Regional Distribution of National Center and Sub-centers of Remote Sensing Application



National Distribution of Counties with Sample Fields

4. Development and Outlook

4.1 Technical Progress. The remote sensing technology now shows trend of fast development, representing more and more commercial satellites and further improvement of pixels of space, spectrum and time of satellite image. Application of new technology further upgrades accuracy and reliability of agricultural remote sensing operation system while the standard of professional operation is also updated gradually. The remote sensing will be the important means of gaining information and become the information collection, treatment and analysis system integrated with conventional statistic survey.

4.2 Expansion of Operations. With gradual growth of operations of agriculture remote sensing, its business will be expanded in following two aspects: 1. expansion of monitoring content, that is, further expanding to monitoring on major crops of oil and sugar crops etc. on the basis of the present 5 crops; and 2. expansion of survey on crop planting area background from current monitoring on annual change of cropping area.

4.3 System Completion. The agricultural remote sensing monitoring system is composted of national center, regional sub-center and ground monitoring network counties. The system is to further develop and improve in organization coordination and quality control etc. and its overall capacity of business operation will be further updated in future.

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