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Data Requirements Analysis Based on China's Agricultural Monitoring and Early-warning

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Abstract: The development of Agricultural Monitoring and Early-warning (AMEW) brings about the requirements for data. According to international experience and China's agricultural situation, this study defined the types of data, acquisition methods and application for AMEW, as well as solved the data requirement analysis. The innovation is based on the connotation of AMEW and the research of business logic and not only historical data was used but also real-time data we draw the conclusion and finish its verification in practical work.

Key words: Data requirement analysis, agricultural monitoring and early-warning (AMEW), China

INTRODUCTION

With the changing situations on agricultural production, marketing and consumption in the global, the researches and work for China's Agricultural Monitoring and Early-warning (AMEW) has been ascending ever since. Up to 2010, China has set up 84 systems for AMEW (Xu, 2013); its network extends to the county-level administrative region.

As a modern strategic resource, data is an important tool to explain scientific phenomena and objective laws of this changing world. So the importance of data research for AMEW cannot be overemphasized. According to present actual conditions, there is countless number of data related to agriculture which are categorized in complex manners; this necessitated the requirements to data characterization. In other word, a well structured data organization system determination has an important theoretical value and practical significance on researches. However, to properly provide accurate guidance for agricultural development, specific data are required by the Agricultural Monitoring and Early-warning System. The analysis of the data required by the system becomes another paramount issue to be solved.

The current program on AMEW mainly focuses on the management system and running mechanism, such as 33-information collection systems established by the Ministry of Agriculture, more than 8000 collection points (MoA, 2011), periodic collection of agricultural production status and market price information; creation on research and model prediction theory, such as CAMES model systems developed by Agricultural Information Institute of Chinese Academy of Agricultural Sciences, tens of thousands of equations have been established, covering 11 categories of 801 kinds of agricultural products. United States Department of Agriculture (USDA), Food and Agriculture Organization of United Nations (FAO) and other relevant organizations have built a mature monitoring and warning system. Although a few institutes (USDA, FAO-OECD, etc.) also forecast or estimate China agricultural issues, they just based on historical data sets rather than real-time data.

This study is based on the specific situations of China's agricultural production, marketing and consumption, making clear which data are needed in the AMEW system, how to classify and collect data, the kind of features and how to process, analyze and the application prospect.

CURRENT RESEARCH

Definition of AMEW: At present, there is no exact definition of AMEW. In general, AMEW covers the whole process of information collection, data analysis, forecasting & early-warning and information release from agricultural production, marketing and consumption, to provide decision support for the decision-making departments, as to provide a reference for the market main body, as shown in Fig. 1.

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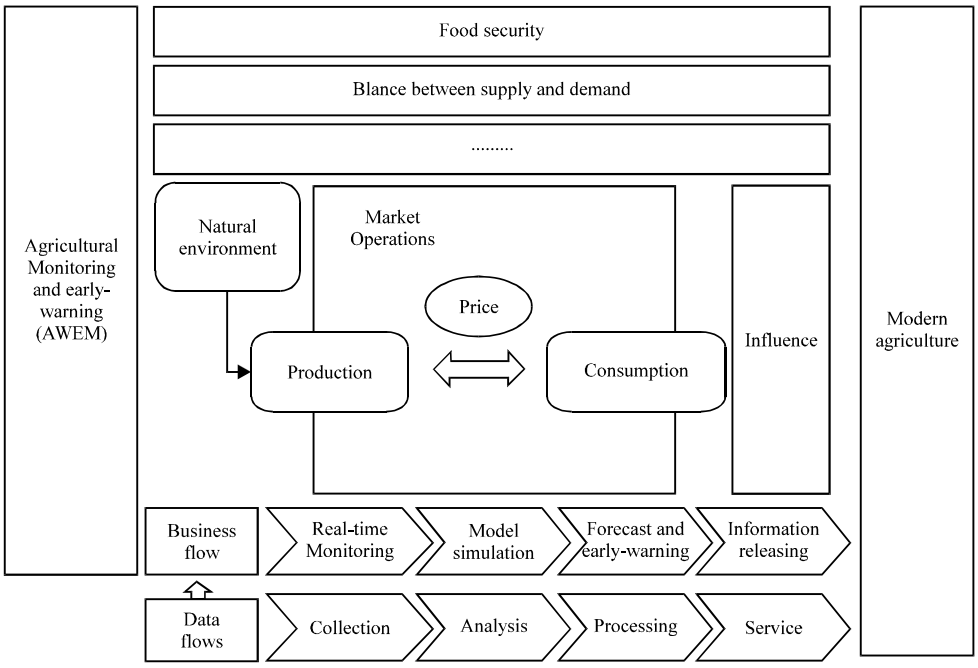

Fig. 1: Agricultural monitoring and early-warning system

Furthermore, the essence of AMEW is the Omni-directional supervision and regulation and comprehensive forecasting and early-warning of the production process, market circulation and food consumption. From the view point of production process, such as agricultural information monitoring and production risk perception; from running market, with price index, including the price fluctuations of the international market and domestic market and the changes in imported and exported products of them; from the point of food consumption, respectively, analysis the food consumption from the angle of amount and diet, study food security and co-ordination of supply and demand problems. These three interrelated aspects are a unity. Therefore, the analysis of data requirements not only need to separate modules, divide level but also integrate and organize date with the viewpoint of system.

Business logic of AMEW: Data requirements are in accordance with the rules of business logic to be analyzed and organized, the analysis of data requirements based on AMEW call for dissection of business process. Business logic of AMEW can be divided into four parts as the real-time monitoring, policy simulation, forecast and outlook and warning prediction, they are independent and yet connective to each other.

According to business logic of AMEW, data is mainly for dynamic monitoring, static query, invoking model and display configuration. Because of the constantly changing of agricultural markets and micro-meteorological disasters, the indicators of real-time monitoring need dynamic monitoring tools; the object of static query are multi-source and fundamental data, which are not allowed to change in order to respect the principle of objective facts; according to the need of model variables, we invoke the fundamental data to compute and evaluate. In this process, it may be necessary to process the basic data, such as the operation of drill-down and roll-up for the data cube and the determination of model parameters; data visualization put forward higher requirements to the display of multi-angle data, so it is necessary to introduce aids for display configuration. The added data from aids also make up a part of the AMEW data.

Research review: Using their advanced analysis, processing and information service technology to complete the data structural system, the developed countries and the relative agricultural organizations have formed theoretical framework and relatively perfect and abundant data resources in both of the construction of AMEW model and the database system, as the result of accumulation of a large number of researches and experience on AMEW.

In respect of the model construction of monitoring and early-warning, the U.S. Department of Agriculture

(USDA) take Excel as a vector to construct a multi- national commodity coupling model (Baseline Model) (Tuan, 2011), including 24 kinds of agricultural subsectors from 43 countries and regions. Based on the balance of supply and demand, the model studies the alternative relationships among the various products (Elasticity of Substitution and Nutrition of Substitution) and the constraint relationship of different cultivated area; the Aglink-CO.SI.MO global model (Vannuccini, 2009), which was jointly developed by Organization for Economic Cooperation and Development (OECD) and FAO, based on a partial equilibrium model of multi-markets, including 59 countries and regions, covered 40 agricultural subsectors. It involved 15,000 equations and 26,000 variables. The types of data contained price, supply (cultivated area, yields/slaughter capacity), demand(food, seed, feeding stuff), trade policy, macroeconomic data (GDP, the core personal-consumption deflator, exchange rates, oil prices), index of production cost etc.; Global Information and Early Warning System (GIEWS) from FAO monitored national food supply and demand, trade development and released warning reports of natural disaster to the public by using all aspects of information resources, such as economy, social culture, politics, weather and natural conditions for agriculture (FAO, 2013; Sakoff, 2012).

By summarizing research status abroad in terms of AMEW data, we can find that the integration of AMEW data carrying out some relevant topics, such as the supply and demand balance, economic accounts for agriculture, food security and natural disaster early-warning and so on. These topics cover all aspects of agricultural production, marketing and consumption by different lever and the data relative to macroeconomic, agricultural policy, export shipping management, climate and meteorology, etc.

DATA REQUIREMENT

National requirements: From an agricultural point of view, China is one country with limited agricultural resources, such as land, water and the resource distribution is not balanced coupled with this limitations are series of natural disasters; comparing with western countries, China has more agricultural population with lower labor productivity. The impact factors on agricultural production, marketing and consumption are complex and changeable.

In order to carry out AMEW more effectively, given the experience from the International and considering China's situation, not only large amount of comprehensive, accurate and basic data are needed but also dynamic data of real-time monitoring is needed. These data are demonstrated in multi-dimensional form by time, region, variety and variables, as well as forecasted by short, middle, long term and predicted by different early-warning line.

Classification by impact factors: By considering agricultural impact factors, data can be divided into three categories including natural resource, production and social economy.

Natural resources data (Table 1) could be divided into three facets such as meteorology, land and water. On the basis of the mechanism of crop growth (photosynthesis, respiration, growth stage) and the influencing factors of aquatic products, the historical climate data and real-time meteorological data could be observed. The meteorological factors are used to reduce/prevent disaster risk; land resources contained farmland and pasture, including quantity (area) and quality (nutrient); Water resources include quantitative data (irrigation capacity, the fishery area) and the qualitative data (water quality).

Production data (Table 2) include plant and animal production, among which, animal production is divided into livestock and aquatic product (breeding stock, slaughter capacity, egg and milk product) and aquatic product (breeding area, fishing scale, output); plant production data include planting area, growth status and production (gross output, yield, yield components).

Social and economy data (Table 3) contains agricultural production condition, agriculture cost-benefit,

Table 1: Natural resources data structure

Level 1	Level 2	Level 3
Meteorology	Crop Growth	Historical
		Real-time
	Aquaculture production	Historical
		Real-time
Land	Farmland	Quantity
		Quality
	Pasture	Quantity
		Quality
Water	Quantity	Irrigation capacity
		Fishery area
	Quality	Water quality

Table 2: Production data structure

Level 1	Level 2	Level 3
Plant production	Area	Planting area
	Growth information	Growth status
		Yield formation
	Output	Gross output
		Yield
		Yield components
Animal production	Livestock	Breeding stock/Slaughter capacity
		Egg/Milk production
	Aquatic product	Breeding area
		Fishing scale
		Output

Table 3: Socio-economic data structure

Level 1	Level 2	Level 3
Production condition	Labor force	
	Capital	
	Technology	
Cost-benefit	Input costs	Material and service costs
		Labor costs
		Land costs
	Revenue	Output value
	Profit	Cash earnings
		Profit margin
Macro-environment	Policy	Monetary/fiscal policy etc.
	Economy	Population/Income/GDP
	Social culture	Standard of Culture/Religion/Habits and Customs
	Industry market	Competitors/Replacer
	Import and export trade	Quantity/Amount
Micro-markets	Producer	Production Capacity/Quality/Price
	Consnmer	Preference/Pattern of Consnmption/Purchasing Power
	Circulate	Sales Channels/Holographic Information

macro-environment and micro-market. Agricultural production condition contains labor force, capital and technology; agriculture cost-benefit includes input costs, revenue and profit, among them, input costs include material and service costs, labor costs and land costs; Macro-environment data mainly includes policy, economy, social culture, geographical environment, industry market, import and export trade, etc., Micro-markets include the producers' production capacity, product quality and price, sales channels and holographic information circulation, as well as consumers' consumption psychology, pattern of consumption, purchasing power, realistic and potential demand, etc.

Classification by intended use: From the point of intended use, data could be divided into four categories: dynamic monitoring, static query, invoking model and display configuration data.

Dynamic monitoring data is mainly about information of market prices, agricultural and meteorological disaster. Market prices contains essential attributes (variety denomination, brand, grade, specifications, price, etc.), spatial attributes (from farm to table: producer, Origin, wholesale and retailed), time attributes (growth period, time-to-market, shelf life etc). Agricultural information contains video surveillance data, meteorological data (temperature, pressure, sunshine hours, relative humidity, precipitation, etc.), soil data (size, moisture content, soil fertility, pH value, etc.) and water data (water temperature, oxygen content, pH value, etc.). Meteorological disasters are consists of the video surveillance data, the disaster recognition and communication consultation data. The disaster recognition applies data from knowledge database which are real-time transmitted. Communication consultation (Ministry of Agriculture of China periodically communicate with institutional researchers) data are consists of real-time voice/video, pictures and text data.

Static query data is a query about historical basic source data by time, regions and varieties. Static query data include five factors such as socioeconomic, natural resource, production, consumption, price, import and export trade data.

According to business logic of AMEW, the data of invoking model include policy simulation data, forecast and outlook data and warning prediction data, which are structured by the parameters of AMEW models, warning line (critical value), related processed data and result data.

In order to meet the demand of multilevel and multi-perceptive data visualization, display configuration data would contain data generated by Geographic Information System (GIS), which take on data of spatial characteristics, data of time characteristics and attribute data.

DATA ACQUISITION AND ITS CHARACTERISTICS

Following the rules and standards of collection, we can use agricultural remote sensing, sensor, perceptive technology, database and computer network technology, traditional experiment, investigation, statistics methods to acquire required data.

In general, besides the characteristics of large quantities and complexity as the general agricultural data, data of AMEW also have the characteristics of multiple sources, many dimensions, dynamism, format diversity, different sources and heterogeneity. The data are involved with agricultural production, macro-environment and variable aspects of the society, which have an extensive source and beyond the range of agriculture; we should analyze the data from four dimension by time, space, products and variables, which decide the characteristics of many dimensions; to deal with the emergency of related agricultural products, the time dimension should be accurate on days, even on hours to monitor some variables, forming dynamic data flow; There

are many structured data as numerical value, unstructured data as text, image, audio/video and semi-structured data as HTML documents among the AMEW data; because of enormous data, unified acquisition standard, the change of statistics standard and lacking available sharing mechanisms, the AMEW data show the characteristics of different sources and heterogeneity, which make it hard to store and process.

DATA APPLICATION

The data of AMEW are widely used. Now-a-days, besides used for real-time monitoring, policy simulation, forecast and outlook and warning prediction, the data can be also applied in data mining, to find the changes of residents' food consumption habits; we can establish data warehouse by subject-oriented data structure to realize data sharing; in addition, food safety traceability can be easily realized by the integration of required data and Internet Things Technology in agriculture.

CONCLUSION AND PROSPECTING

Through the research on the connotation of AMEW, statics data structure and model application of international organizations, from the perspective of business logic, this study discovered suitable type of data frame required for monitoring and early-warning system.

With the explosive growth in data nowadays, it has been difficult to analyze and deal with data of AMEW by traditional database technology. So, how to introduce the concepts of big data and processing technology into the standardization and data processing of AMEW research are the study contents in next generation.

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