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The grain potential of cultivated lands in Mainland China in 2004

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ABSTRACT

The regional test yields of certificated cultivars of grain crops represent the potential yields for the given region under the current natural and technical conditions. Therefore, it is appropriate to use the regional test yields to estimate the gross grain potential of Mainland China.

In this paper, we calculated the grain potential of cultivated lands for each of the 105 agro-ecological regions in China. First, cropping system in each agro-ecological region was assumed to be the best use of the agro-climatic resources. Second, the potential per hectare for each of the crops was calculated for a given agro-ecological region, based on the regional test yields of certificated cultivars of grain crops in a given cropping system. For rain-fed and dry lands, their grain potentials were further modified by water-restricting coefficients. The water-restricting coefficients were calculated by dividing the hydro-thermal potential with the corresponding photosynthesis-thermal potential for different grain crops, which were obtained from *Regulations of Farmland Grading*. Thereafter, the grain potential per hectare of each agro-ecological region was calculated considering the cropping system and the potentials per hectare of all the crops in the cropping system. The gross grain potential of each county in a given region was then obtained by multiplying the grain potential per hectare and the total area of cultivated lands in the county. Finally, the gross grain potential of each agro-ecological region and the whole Mainland China were obtained by summarizing the grain potentials for all of the counties. The results showed that the gross grain potential of Mainland China was 0.92 billion t in 2004. It should be pointed out that this calculation on the grain potential did not sufficiently consider the crop growth restricting factors of cultivated lands, such as soil fertility, fertilizer input, and so on. Since the grain potential is far above the actual grain yield, it suggests that the cultivated land assurance for grain security in Mainland China is relatively high. The results of each agro-ecological region showed that the highest grain potentials were distributed in Huang-Huai-Hai Plain, Northeast China, Middle and Lower Reaches of Yangtze River and Sichuan Basin, where excellent hydro-thermal condition and flat terrain are ideally suitable for crop growth.

Introduction

With the growing contradiction between rapid and continuous population growth and the associated increasing demands on agricultural products and the limited supply of water and land resources and its rigid restrictions to grain potential, food security in China has attracted the attention of scholars' home and abroad (Cao et al., 1995; Liu and Wu, 2002). Lester Brown, president of the World Watch Institute in the U.S.A., twice wrote about the "threat in food supply in China", focusing on the problem of shortage of cultivated land and water resources and its impact on food security in China (Brown, 1995; Brown and Brain, 1998). After continuous abundant grain harvests for a period from 1995 to 1998, the annual total grain yield in China declined continuously from 1999 to 2003, shifted the overall balance between grain supply and demand, and led to a great increase in grain price in 2003 (Chen and Yu, 2004). As a result, food security in China has become a hot topic again. At "the Advanced Forum of Food Security in China", held on 16 October 2004, many prominent experts cautioned that one should not feel optimistic about the status of grain production in China.[1]

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In fact, the key strategy for food security should not based on the annual grain yield, but rather on establishing a security system for grain production elements that prevents the grain productive capability from being damaged. In other words, the stress of food security should be transferred to lay on the security of crop productive capability from the security of crop yield (Lu and Xu, 2004). Cultivated land resources are not only basic elements of grain productive capability, but also "a tug at elbow" that limits the development of China's potential for the time being (Cai et al., 2002). Therefore, calculation of grain potential of cultivated lands provides a base for analyzing the assurance situation of food security.

For a certain grain crop in a given area, the grain potential of cultivated lands is a reachable yield, restricted by local natural resources and current technical and economic conditions. At present, the productive potential is commonly estimated by mechanism method and by yield investigation method. To use the mechanism method, model parameters need to be determined first (FAO, 1978, 1982). However, there are not sufficient parameters for crop production model in China at present. Using parameters in *Relationship between Production and Water* edited by FAO, the calculated crop potential deviated significantly from the actual productivity in China (Hu et al., 2001). In order to make the calculated results to be close to the practical grain productivity, this method was further modified by land quality (Dang et al., 1998; Chen, 2001). To use the yield investigation method, the grain yields of high- and steady-yield plots need to be established by a wide ranged survey from institutions or individuals related to crop production. Although this method treated the crop growth process as a "black box", the calculated grain potential was reasonably realistic (Lin and Shen, 1996). Therefore, in this paper we employed the yield investigation method to calculate the grain potential. Considering the difficulty in selecting representative objects and samples, and more importantly, the difficulty involved in carrying out such a broad yield survey throughout the whole nation, we use the regional test yields of certificated grain crop cultivars as the base for calculating the grain potential per hectare of cultivated lands.

Methods and data sources

Nationwide regional planning of agro-ecological areas and identification of cropping systems in agro-ecological regions

The identification of cropping systems is a precondition for calculating grain potential of cultivated lands. A cropping system includes crop composition and distribution, multiple cropping and planting patterns, such as intercropping, relay cropping, crop rotation and continuous cropping (Liu and Han, 1987). Each of the cropping systems chosen in this paper included a specific grain crop or a specific series of grain crops which were deemed to be ideally suited for the climate and thus could sufficiently utilize the agro-climatic resources for the given area (Fischer et al., 2002). Therefore, regions with similar climate and topography were analyzed using one cropping system.

In "the Agro-Ecological Regional Planning Design of China" study, a sub-project of the "Efficient Use and Management Technology of Agricultural Resources" research project (which was one of National Ninth Five-year key technological projects aimed at tackling key problems), the whole nation was divided into 12 agro-ecological zones, 49 agro-ecological subzones and 105 agro-ecological regions without breaking the boundary of counties (Fig. 1). The zones were divided according to temperature and precipitation, the subzones were further divided according to topography, and the regions were further divided according to soil and other limiting factors to agricultural production (Chen, 2001). As such, every agro-ecological region had uniform natural conditions and unique or similar cropping systems. We analyzed the agricultural production factors of the 105 agro-ecological regions, identified its cropping systems.

The cropping systems for every agro-ecological region were simplified and adjusted in considering the following: (1) satisfy the needs for the calculation of grain potential of cultivated lands; (2) based on the results from "the regional planning of the standard farming system of China", part of *Regulations of Farmland Grading*, which was developed in "the project of land

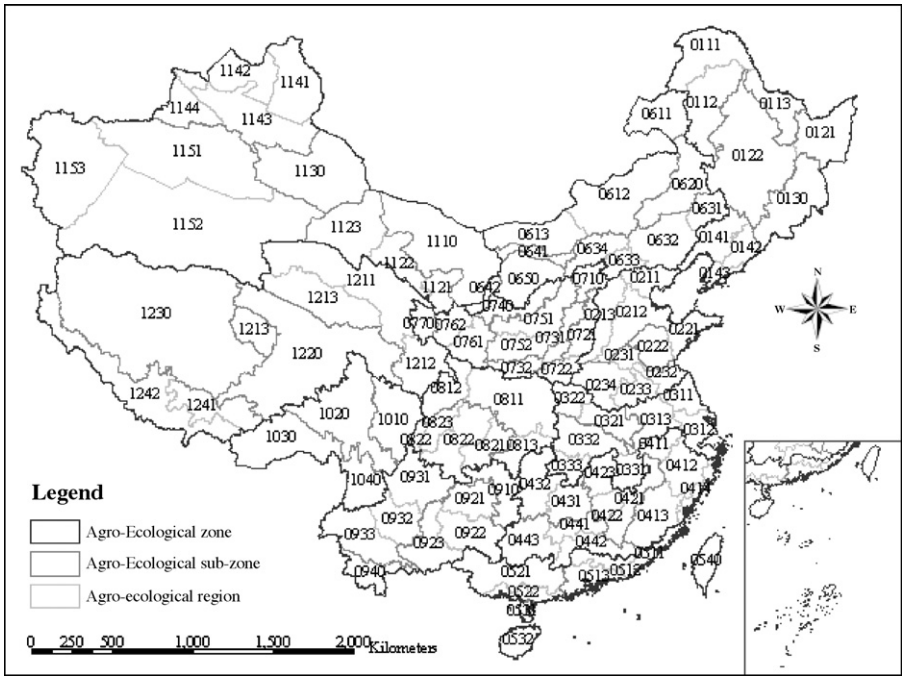

Fig. 1. The agro-ecological regional planning of China.