



Food security: A multi-faceted and multi-dimensional issue in China

Victor R. Squires *, Limin Hua and Guizhen Wang

College of Grassland Science, Gansu Agricultural University, Anning District, Lanzhou City, Gansu Province, Postal code: 730070, China. * e-mail: dryland1812@internode.on.net, hua-lm@263.net, wgz2013@sina.cn

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Abstract

This study on China, the country with the biggest population, the greatest area of desert and desertification and the fastest growing economy, covers many aspects of the food security issue. We begin by defining what is meant by food and what is understood by food security. The two main aspects (having enough to eat and being sure that it is safe to eat) are explored. The role and importance of China's national grain reserve is highlighted and the vulnerabilities associated with climate change, urbanization and the impending water crisis are reviewed. The scourge of food wastage and the importance of changing the mindset of citizens receives attention. The aim of the paper is to analyse the critical role that food security occupies in China and the policy implications of some government initiated projects, including inter-basin water transfers and the merits of re-thinking the potential role of virtual water in international commodity trade.

Key words: Food safety, virtual water, water scarcity, arable land, green food, grain reserves, grain imports, hygiene, self sufficiency, water footprint.

Background - What Is Food?

In a general sense food is any substance consumed to provide nutritional support for the body. It is usually of plant or animal origin, and contains essential nutrients, such as carbohydrates, fats, proteins, vitamins and minerals¹. More specifically when we think of food we adopt a more specific definition and what is regarded as food depends on the culture and the circumstance². Some cultures eat a lot of insects and other invertebrates, including sea creatures, others only eat products (milk, meat, honey) from specific animals. The religious beliefs can also influence food selection, pork is prohibited to Moslems, Jews and some others, dog meat is favored by Koreans and some Chinese, donkey meat is eaten in China but rejected in Ethiopia and so on. Plants are favored in the diets of most people, some to the exclusion of animal products even to prohibitions on milk, eggs etc. Some plants require considerable preparation before ingestion. This may be to remove toxic compounds. Others require pre-treatment before cooking (soaking, maceration) to make them digestible.

Controversy erupts from time to time over the use of specific animals (in particular) as food. For example, there is a movement to prohibit sale of dog meat for human consumption and in some areas cats are used as a substitute for pork. There is an evidence that the use of wild animals may have contributed to the spread of SARS³. Reports surface from time to time of people using the meat of rodents such as rats (*Rattus norvegicus*) as a substitute for mutton and so on. For others rats such as bamboo rats are a common element of the diet in south China.

From this we must conclude that almost anything can be regarded as food but for the purpose of this paper we are concerned about

feeding the masses, and the most common way to do this is with food grains, rice, wheat, maize and in China, especially, edible oils for cooking.

Food Security – Means Different Things to Different People

The concept of food security has two main meanings: (1) having enough to eat and an assured supply (2) safety concerns about purity and hygiene. We are concerned because every country on earth has a national policy on food security and most countries try to ensure a food reserve. Food security has two dimensions. On the one hand there is concern about whether sufficient food grain is in storage to survive a prolonged drought when crops fail, or military action blockades delivery etc, and the second is with food safety and health. We will explore both aspects here.

The Food and Agriculture Organization (FAO) of the UN defines food security as follows: "Food security exists when all people, at all times have access to sufficient, safe and nutritious foods to satisfy their dietary needs and food preferences for an active and healthy life". These criteria are unlikely to be met for any nation on the UN membership⁴. Proposed variation used by the US Department of Agriculture focuses on the household level and states that "Food security for a household means that there is access for all members at all times to enough food for an active healthy life". Food security is a human right. The right to food, is a human right, protecting the right for people to feed themselves, implying that sufficient food is available, that people have the means to access it, and it adequately meets the individual's nutritional needs is government responsibility. The right to food

protects the right of all human beings to be free from hunger, food insecurity and malnutrition. The right to food does not imply that governments have an obligation to hand out free food to everyone who wants it, or a right to be fed, but a major responsibility of the national government is to have enough food at reasonable prices to ensure that no one goes short. Further discussion is on the various definitions and the qualifying criteria of food security (and food insecurity), especially in the context of China⁵.

China's Food Security (And Insecurity)—A Major Preoccupation

China is inhabited by ca 20 percent of the world population, but has only 7 percent of global arable land and only 6.6 percent of global freshwater resources. These unfavorable relationships between population size and the basic resources for food production, soil and water, require careful food security and contingency planning by the Chinese authorities. The country has been remarkably successful in raising its food production since 1949 at a faster rate (400 percent) than the increase in its population (240 percent). This has basically been achieved by increasing the yields per unit area with enhanced fertilizer use, as the total size of arable land has been decreasing in recent years. Urbanization proceeds at a rapid pace bringing further losses of arable land as urban centers grow and creating a demand for food grains and, increasingly, more meat. All of this means that food security (having enough) and it being safe to eat, is high on the agenda in China today.

With the projected increase in China's urbanized population and change in food habits, the future food demand for cereals and meat products will increase drastically⁶. Therefore, among China's principal concerns of the twenty-first century are: (1) food security due to a rapid increase in the urban population, (2) soil degradation by land misuse and soil mismanagement and (3) anthropogenic increases in atmospheric greenhouse gases. All of these issues are linked to the issues surrounding food security.

Only a few decades ago a major responsibility of the Mayor of Beijing was to ensure that there was enough cabbage for everyone to last them for the winter. It was commonplace to see stacks of cabbage at the end of every street and laneway in the *hutongs*. Nowadays more reliance is placed on food grains such as rice, wheat, maize and millet. To this end large-scale storage is provided to keep at least 9-12 month's supply of these grains in reserve against a calamity that might result from crop failure or transport disruption or other events (e.g. blockades) that prevent delivery from abroad. China currently stores million tons of food grains in purpose-built facilities. As a developing country with a population of more than a billion, grain has always been the first and foremost issue to maintain peace and stability.

There is stockpiling of domestic grain and appropriate imports to build national grain reserves which cover about 90 percent of national consumption by 2020. Wheat, rice and corn will account for 85 percent of the inventory, while the reserves of edible oil and oil seeds can meet the demand of one fourth of consumption. In 2014, about 80 percent of grain warehouses will be filled by domestic production and the rest will be covered by imports. Since 1998, in order to improve grain reserve conditions, China has invested with RMB¹ 34.3 billion in building 1,114 national grain reserve depots (capacity of 105.1 billion cattiesⁱⁱ). By concentrating

central grain reserves at strategic points with good storage conditions, and strong geographic advantages, the number of reserve depots has decreased from more than 10,000 to current 1,114. Such gigantic grain reserves need the best grain storage technology and smart grain warehouses. In the past enormous losses were reported each year from attacks by rodents, fungi and insects. Serious losses were also experienced from poor transport equipment, lack of dedicated bulk grain rolling stock on the railways.

According to regulations governing the administration of central grain reserves issued in 2003, China will annually rotate 20 to 30 percent of its total central grain reserves based on domestic supply and demand. This will help ensure that quality grain is always available. Grain that is damaged or mold-affected can be sorted and diverted to stock feed.

Rising disposable incomes are leading to more diverse and animal protein rich diets, increasing demand for food and feed products. Large government support programs targeting grain production have led to steady reported increases in corn, wheat and rice production over the past 10 years. However, limited water resources and degraded arable land as a result of industrial pollution, overuse of fertilizers, and single cropping make production increases difficult and place a significant strain on Chinese agriculture resources.

Food Self-sufficiency in China – An Economic and Political Imperative

Food self-sufficiency is not within China's grasp yet and imports of wheat, for example, can exceed 14 million tons/year⁵. China's grain production totalled more than 500 million tons in 2012. This is 70.85 million tons more than in 2003 when shortages were widespread. China's annual grain output in 2013 reached 601.935 million tons. Grain output has expanded 2.1 percent year on year the 10th year in a row of increased grain production. National grain acreage must be kept stable, at around 1.07 billion hectares. Rapid urbanization is one reason grain fields are dwindling. Fundamental changes, including shrinking acreage and natural disasters, herald the end of the years of oversupply, according to some experts but official government reports say the China will maintain a high rate of self-sufficiency in major grain output and realize the food security target for the ten years 2014-2023 (Chinese Academy of Agricultural Sciences)ⁱⁱⁱ. The grain self-sufficiency rate stood above 97 percent in 2013 and cereal imports reached only 14 million tons^{iv}, accounting for less than 2.6 percent of cereal output. Wheat stocks in 2014/2015 are forecast at 62 million tons, 4 million tons higher than the previous year on continued record production and large government purchases. There are no public official statistics on wheat stocks. Rough rice (unmilled) production in 2014/2015 is forecast at 204 million tons based on average yields and a slight rise in area planted.

China has kicked off a massive construction program in small towns intended to transform more than 200 million farmers into urban residents by 2020, and economists predict that China's urbanization rate will reach 60 per cent in 2020 compared with 37.7 per cent in 2001. The latest government statistics indicate that more than 90 million rural laborers were working in cities at the

ⁱAt the time of writing 1 US dollar was worth 6.2 RMB, ⁱⁱ cattie = 500 g

ⁱⁱⁱhttp://www.china.org.cn/china/Off_the_Wire/2014-04/20/content_32152706.htm

^{iv}Following a series of dry years and poor yields around 2003 wheat imports reached 20 million tons

end of September 2013. To counter the loss of arable land to urban and infrastructure developments, a red line has been drawn to ensure that arable land shall never shrink to less than 120 million hectares (not all arable land grows food crops) as food security has always been one of the top concerns for China.

With the exception of a portion of demand for soybean, which is supplied from overseas, China has been self-sufficient in wheat, rice and corn. China is now the world's biggest importer of rice and commonly accesses about 20 million tons of wheat from the world market. Currently skyrocketing grain prices are primarily driven by soaring demand for biofuels as well as rising machinery, fertilizer, labor and farming land costs, but China is working to stabilize grain prices. The government annually raises grain procurement prices to encourage farmers to plant key staple crops for grain self-sufficiency, such as rice, wheat and corn. Government floor prices and temporary reserve programs have boosted production of corn, wheat, and rice. In general, these programs keep domestic prices relatively stable and above international levels. China attaches great importance to grain self-sufficiency and so these programs are likely to continue in the coming years. With China's large population, the task of simply feeding the people remains a high priority, Government price support encourages farmers to plant rice as a component of food security. Since 2004, domestic wheat production has been purchased and stored by state grain companies under the government's minimum purchase price program. The government provides state grain companies preferential loans to purchase the wheat and subsidizes storage costs. The State Administration of Grain (SAG) organizes regular wheat auctions throughout the marketing year as necessary to meet demand or rotate stocks.

Under a new policy guideline^v the government will try to maintain self-sufficiency in wheat and rice, but will allow "moderate" grain imports for feed while keeping grain reserves at a scale equivalent to 17 percent of market demand. This idea is a break from previous policies that sought to maintain 95 percent self-sufficiency for corn, wheat and rice. This policy change may allow for growth in corn imports in the long run. The wheat is sourced from many countries (see Table 1) but Australia is a major source of wheat, barley, and red sorghum. Soybean remains the primary grain import, which rose 8.6 percent year on year to reach 63.4 million tons in 2013. Soybeans are mainly imported from USA. China is also heavily dependent on imports for cooking oil.

Table 1. Countries allowed to export grains to China.

Wheat	Australia, Canada, France, Kazakhstan, Hungary, United Kingdom, United States, Serbia and Mongolia
Corn	Thailand, United States, Peru, Laos, Argentina, Ukraine, Bulgaria and Brazil
Barley	Australia, Canada, Denmark, France and Argentina, Mongolia and Ukraine

Source: AQSIQ Official Notice updated in January 2014

Role of Grain Reserve Corporation Activities in China

China Grain Reserves Corporation (Sinograin) is a state-owned enterprise which plays a key role in caring out state initiatives to

^v President Xi Jinping announced a new food security strategy at the annual central economic conference in December 2013

ensure China's food security and economic growth. Founded in 2000 with a registered capital of RMB16.68 billion, Sinograin has grown into one of the largest and most wide ranging grain storage and transportation corporations in China and is a leader in the research and use of innovative technology and equipment.

Mission of Sinograin is to guarantee the stocks are in bona fide quantities and good quality, that is, make sure the size of the depot determined by the central government be supported by bona fide physical stocks, to provide sufficient grain resources for national deployment; meanwhile, the grain stocks must conform to the national quality standards, and grains that expire the maximum storage period shall be replaced by new qualified grains. Guarantee deployment in place and in time, that is, grain stocks can be transferred out of the depot in an highly efficient and rapid manner upon directions by the state, and launch the grains in the market strictly according to the requirements of the government's macro regulation in terms of time, location, quantity and variety. to develop two contingency plans, respectively, for emergency use and emergency processing for central grain reserves in case of crop failure of natural catastrophe.

Activities of China Grain Reserve Corporation (CGRC) include:

- Assume the task of governmental protective purchase of grain across the nation. In 2008, implemented the minimum purchase price as well as temporary collection and storage policy in 24 provinces and regions in China with total purchase of 83.5 billion cattles of wheat, 27.3 billion cattles of rice, 26.3 billion cattles of corn, 1.2 billion cattles of soybeans and 1.3 billion cattles of rapeseeds.
- From 2005 to 2008, Sinograin had purchased a total of 320 billion cattles grain to support the market, which resulted in direct income increase by more than RMB 8 billion for grain-growing farmers, effectively protected their interest and held a large deal of grain resources for the country's regulation of grain market.
- Assume the task of auctions to stabilize grain prices and increase market supply.
- Sold 500 million cattles of central edible oil reserves by way of oriented marketing, designated processing and direct provision for the market; auctioned off 83.2 billion cattles of grain for administrative purpose; released 1.3 billion cattles from central grain and oil reserves into earthquake-hit areas in Sichuan Province in 2008.
- Put into the market 0.4 billion cattles of central oil reserves, 1.2 billion cattles central corn reserves, 74.3 billion cattles wheat and 36.5 billion cattles rice with minimum purchase prices in 2007.
- Launched into the market 13.5 billion cattles "minimum purchase price" rice and 10 billion cattles "minimum purchase price" wheat in 2006.
- From 2005 to 2008, Sinograin had sold a total of 220 billion cattles administratively-purposed grain and edible oil, which effectively increased market supply and played an active role in suppressing the quick rise of grain prices.
- Assume the task of large-scale cross-regional deployment and balance of grain across the nation.
- Accomplished 14.3 billion cattles of shipment for cross-regional deployment in 2008. The branch companies in three provinces in northeast of China moved 13.4 billion cattles of grain by railway through "major railway clients" platform.
- From 2005 to 2008, Sinograin totally transported 26 billion cattles

of grain and edible oil for the administratively-purpose, which improved the structure of China's grain reserves, increased the grain storage in key distribution and grain-short areas, and laid a solid foundation for the continuity of national grain macro regulation policy.

- Assume national import and export task of grain and oil.
- Utilizing international market and resources is an important means of balancing domestic grain supply and demand. According to the national plans, Sinograin assumes the tasks of acceptance and discharge of imported grain, port transportation and dedicated reserves as well as the purchasing and exporting of some of domestic grain types.
- Devise a national warning mechanism that should be established to include all necessary information concerning grain production, circulation and reserves as this is vital to ensuring quick, scientific macro-adjustments by the government.

Virtual Water – Implications for China

Most of the water used in China, 92% of it, is used in food production (much of it invisible or virtual). The adjective 'virtual' refers to the fact that most of the water used to produce a product is not contained in the product. The real-water content of products is generally negligible if compared to the virtual-water content. The virtual-water content of a product (a commodity, good or service) is the volume of freshwater used to produce the product, measured at the place where the product was actually produced (production-site definition). It refers to the sum of the freshwater use in the various steps of the production chain⁷⁻⁹. The virtual-water content of a product can also be defined as the volume of fresh water that would have been required to produce the product at the place where the product is consumed (consumption-site definition). The virtual water content of products increases when additional resources are required for their production such as processing, packaging and transport. For example, processing of rice suitable for retail sale requires 50% more water than that required to produce the raw ingredient. The virtual-water concept¹⁰ was introduced as a partial solution to problems of water scarcity in the Middle East. It involved the concept of the possibility of importing virtual water (as opposed to real water). The idea of using virtual-water import (coming along with food imports) as a tool to release the pressure on limited available domestic water resources was promoted. Virtual-water import thus becomes an alternative water source, alongside endogenous water sources. It has implications for how China balances its water scarcity (see below) and the import of food grains, beef etc.

Traditional national water use accounts only refer to the water use within a country. In order to support a broader sort of analysis, the accounts need to be extended. The water footprint of a nation has two components. The internal water footprint is defined as the water used within the country in so far as it is used to produce goods and services consumed by the national population. The external water footprint of a country is defined as the annual volume of water resources used in other countries to produce goods and services imported into and consumed in the country considered. It is equal to the virtual-water import into the country minus the volume of virtual-water exported to other countries as a result of re-export of imported products. China as a major manufacturing country exports a lot virtual water. For example, one cotton t-shirt requires around 2000 litres of water to produce.

The water footprint concept was introduced in 1990¹¹. The water footprint of a good or a service is the total amount of water, external and internal, that is required to produce it. The concept can be used to calculate and compare the strain on water resources resulting from different options. It can also be extended to provide water budgets for whole nations or continents. The idea of the water footprint is quite similar to the ecological footprint, but focusing on the use of water. Water footprints are calculated using the virtual water content of products and services. The virtual water content of a product is the volume of water required to produce it. The 'water footprint' has been developed as an analytical tool to address policy issues of water security and sustainable water use¹². The water footprint shows the extent and locations of water use in relation to consumption by people⁹. The water footprint of a community is defined as the volume of water used for the production of the goods and services consumed by the members of the community. The water footprint of a nation is an indicator of the effects of national consumption on both internal and external water resources. The ratio of internal to external water footprint is relevant, because externalising the water footprint means increasing the dependency on foreign water resources.

By far, the greatest single factor contributing to the global water footprint is crop production, responsible for about 85% of all water use. Rice production is the highest water consumer, accounting for about 21% of the total water used for crop production, while wheat production is the second highest consumer, at around 12%.

National water footprints vary due to four main factors:

- The first is volume of consumption, which is directly related to the gross national income of a country. Wealthier countries are higher consumers therefore they have higher water footprints.
- The second factor is the type of goods consumed by a population. Some goods requires more water than others to produce, therefore their consumption can contribute to a higher footprint. Because meat requires a far greater volume of water to produce than other foods, countries with high meat consumption tend to have larger water footprints. The amount of meat in our diet is crucial. The average daily water consumption of a meat-eating person is 5000 litres of water per day. The average for a vegetarian is 2500 litres. Unfortunately as incomes rise in China and people move to urban centers, meat consumption rises⁶.
- Climate is the third factor, because the availability of water due to climatic conditions has a direct impact on the amount of water available for use.
- The fourth factor is efficiency of water use in agriculture. Low water productivity due to poor management of water resources for agriculture can contribute to a higher footprint. This is an area where China needs to focus as much of the irrigated land is yet to convert to water-saving agricultural practices.

Trade in virtual water: Although in most food consumed in China still originates from the country itself, substantial volumes of food and feed are internationally traded. The international trade in agricultural commodities at the same time constitutes a trade with water in virtual form. Water in external areas (the exporting countries like Australia, USA etc) has been used to produce the food and feed items imported. As a result, China imports water in a virtual form, i.e. in the form of agricultural commodities like food

grains, cooking oil and beef, but also grains like barley and red sorghum that are used to produce alcoholic beverages like beer and liquor or to be fed to livestock. The whole question of virtual water needs much attention from China's policy makers. Whilst there is clear merit in having ample grain reserves it is to be noted that much of what goes into storage has been produced in China under conditions where precious water has been used in a 'less less than a water-efficient way'. Importing rains like wheat soybean and maize 'saves' a lot of water (import of soybean may be mainly because of saving a lot of land, since soybean yield is low).

China's Impending Water Crisis

Fresh water is increasingly scarce, particularly in China. The average annual supply, per capita, is 348 m³. The UN defines anything below 1000 as a water shortage. Thousands of rivers and lakes in China that have dried and disappeared after decades of declining rainfall, prolonged droughts, exploding population growth, industrial expansion, and a series of poorly planned and sited reservoirs built during the early days of New China. For example, Hebei province, which neighbors Beijing, has seen 969 of its 1,052 lakes dry up; some of its farmers water their crops with sewage water which has implications for food safety.

China's natural water supplies are unpredictable. Major shifts in the weather can suddenly cut off supplies in an era when increasing urbanization and industrialization are raising the demand for water. For example, water levels in the Yangtze and Yellow rivers have been falling. The amount of water entering the Yangtze from glaciers on the Tibetan plateau had fallen by 15% over the last four decades since the 1970s. Glacial retreat is a serious cause for concern. Total freshwater reserves in the Yangtze River Basin in 2009 had fallen 17% from 2005 levels¹³. One of the north's main water sources, the Yellow River, has been shrinking for the past three decades, drying up almost every year before reaching the sea.

By 2030 when China's population reaches 1.4-1.5 billion, per capita water resources will drop to 1,760 m³ — perilously close to 1,700 m³, the internationally recognized benchmark for water

shortages. China's water consumption is expected to peak by 2030 and if no effective measures are taken, the country is likely to suffer a serious water crisis in the future. Statistics show that the combined area of the three valleys of the Yellow, Haihe and Huaihe rivers account for 13.4 percent of the country's total territory. Arable land, population, and gross domestic product (GDP) of the three river valleys make up 39 percent, 35 percent, and 32 percent, respectively, of the national totals, but water resources in the three river valleys account for only 7.7 percent of the national total. Per capita water resource in the three valleys stands at 500 m³, so there are areas where the water shortage is the most serious in the whole country. Along with the worsening water crisis, many rural and urban areas north of the Yellow River have run into difficulties by relying on over exploiting underground water resources to sustain their social and economic development. North China is now using underground water formed 10,000 years ago. The North Plain, a region that is home to a quarter of China's population and major production base for wheat and other food grains (Fig. 1), is especially dry. Here, water tables are falling by two to three m per year, posing serious risks to agriculture and food security. Of China's 22 provinces, 11 were considered 'water stressed' meaning they have less than 1,000 m³ of water per person a year as of 2012.

Plans to divert water from the northeast provinces to Beijing and some hydropower projects will have dire consequences for millions of peasants. The government has launched a grandiose \$60bn "south to north water diversion project" that will channel about 1.2bn m³ of water a year from wetter southern provinces to the country's arid north. Many experts have criticized the scheme for being short-sighted and say the concrete reservoirs and channels being built to transport the water from the Yangtze River will increase evaporation and lower already depleted water tables by reducing the amount of water absorbed into the soil. The first phase of the South-to-North Water Diversion Project (SNWDP) began operating. The project's eventual goal is to move 44.8 billion cubic meters of water across the country every year.

Looking at the long term, the roots of China's problems are an

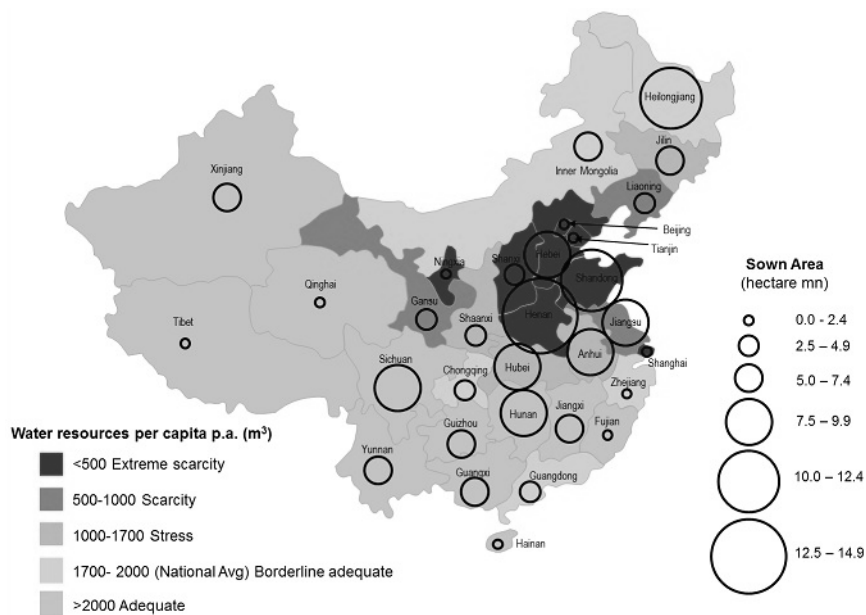


Figure 1. China's principal areas for growing food grains such as wheat, maize and millet are in the areas that are the most water stressed. Source: chinawaterrisk.org. (Used with permission).

irrational industrial structure, pollution and overuse of underground water supplies. If groundwater extraction in the north continues at current rates, in 15 years there will be none left. Reductions in supply of water from all sources, has caused the overall ecological environment to deteriorate. There are serious implications for food production, as water for irrigation dries up, and real threats to food security.

In the coming decade, every city in China will try aggressively to follow a path of modernization, urbanization and industrialization. Yet it will be a huge challenge to guarantee the water needs for agriculture while at the same time meeting the water demands of rapidly modernizing urban centers. As people move from the rural areas to the urban centers water use per person increases sharply. Tap water for bathing, laundry, and flush toilets etc mean that whereas 20 l/person/day was the norm it will quickly rise to 80-100 l/day. Urban dwellers will depend on produce markets to supply their food. Farmers will need more water to grow food for the burgeoning cities. Part of the solution must be stricter water resource management. China has, for a long time, treated water as a public good that was free for everyone to use. In the future, following the unification of water use rules nationwide, the perception of water will change. The water price should rise with stricter rules and penalties for improper use of underground and surface water supplies. One reason why China's water crisis is so dire is that the central government hasn't been able to coordinate national efforts to conserve water. Local environmental bureaus are often weak. Although the Chinese government also set the redline of water use not exceeding 700 billion cube meters in 2030 it is not clear how this will be achieved.

Arable land is also in limited supply and the area under cultivation continues to decline. Productivity of the land is problematic¹⁴. The population growth and demand for high living standard not only increase food demand but also cause more loss of the limited cultivated land resources. Cultivated land loss caused by disasters and the implementation of the "Conversion of Cropland to Forest or Grassland" project make this situation even worse in China. Thus, there is a problem to be solved imminently that to what extent the cultivated land can guarantee food security of China. Food supply can only be maintained at a low to middle level of 370-410 kg per capita, that is, China has enough land productivity to meet primary demand of food independently¹⁴. However, it cannot reach the safe target of 500 kg per capita if there is no breakthrough in plant breeding or no remarkable improvement of irrigation efficiency, when the level of grain self-sufficiency maintains at no less than 80%. To breed productive crops and to improve land productivity by ameliorating low quality cultivated land are appropriate measures to shrink the gap between food demand and supply.

Rural Vulnerability to Environmental Change in China's Irrigated Lowlands

With its food security depending almost entirely on irrigated agriculture, the major food grain producing regions of China are highly vulnerable to water scarcity. Those rural areas dependent on irrigation water, most of the food production regions in China, are highly vulnerable to changes in the uplands where the major rivers arise. The Qinghai-Tibet Plateau is home to many major rivers like the Yangtze, and Yellow rivers (some are transboundary rivers like the Bhramaputra and the Lancan/Mekong) and several

inland rivers that provide water in the arid Hexi corridor of Gansu Province. Warmer temperatures are causing glaciers to melt. Retreating glaciers no longer hold water in long-term storage. Ongoing environmental degradation in the headwaters of these major rivers is a serious concern that threatens for millions food security. A key question is 'will mountain systems provide sufficient water-based eco-system services into the future'? The continued flow of ecosystem services depends on how much attention is paid to land stewardship by upstream users. Land stewardship and the adoption of a landscape management approach will not only protect the headwaters but provide a sustainable supply of water and other ecosystem services to people in the lowlands. A landscape approach examines such larger areas to more fully recognize natural resource conditions and trends, natural and human influences, and opportunities for resource conservation, restoration, and development. The approach seeks to identify important ecological values and patterns of environmental change that may not be evident when managing smaller, local land areas. A landscape approach informs and enhances local management. Specifically, to ensure food security in these vulnerable lowlands there must be an improvement in water use efficiency accompanied by a change in the cropping patterns that currently have a high potential to expose sensitive rural communities to climate risks. In addition, changes in land use such as the afforestation of degraded croplands, and introducing resource-smart cultivation practices such as conservation agriculture, may strengthen the capacity of farmers and institutions to respond to climate challenges in the irrigated food grain producing lowland regions in China.

Effects of poor water management and allocation on food security: The effects of poor water management and allocation on food security can be summarized as follows: "Where irrigation is concerned, over-abstraction can lead to waterlogging and hence long-term or permanent soil deterioration and reduced productivity. It furthermore reduces environmental stream flows, which clearly reduces access to water for productive (as well as other) uses by downstream stakeholders. These uses include not only more irrigation, but water allocations for urban and industrial users"¹⁵.

Food Safety – A Major Concern

No issue has created such unease as the matter of food safety. The basic question is 'how safe is my food'? China has been rocked by scandals of illegal additives in milk, high heavy metal content in rice, substitution of rodent meat for mutton and concerns about hygiene in slaughter and processing of meat. Pesticide residue and fecal matter contamination in vegetables is also a concern.

The government has been strengthening regulations about food handling and have tightened the rules about marketing products that do not comply with guidelines such as those relating to the interval (number of days) between a pesticide application and delivery to a market. Stricter rules apply to use of certain banned pesticides. Some of the ones still in use in China have been banned for many years in the EU, USA and other developed countries. The addition of illegal and dangerous additives to dairy products such as milk, infant formula and ice cream, in particular, but also cooking oils is matter for great concern^{vi}. Fish and other sea

^{vi} <http://globaledege.msu.edu/blog/post/1508/china's-food-safety-scandals>

foods can be contaminated with heavy metals (mercury, chromium, cadmium) especially shell fish that are filter feeders, or other chemicals originating from oil spills that discharge petrochemicals into coastal waters like the Bohai Sea. Fish farms are also suspected. Small farms, high demands and lax oversight are inspiring fish farmers in China and Southeast Asia to feed their fish, especially tilapia, with animal feces. In many cases, fish have been raised on diets of chicken and pig feces.

The Chinese government oversees agricultural production as well as the manufacture of food packaging, containers, chemical additives, drug production, and business regulation. The Chinese government attempted to consolidate food safety regulation with the creation of the State Food and Drug Administration of China in 2003; officials have also been under increasing public and international pressure to solve food safety problems. As urban consumers' incomes increase, the demand for quality food goods, safer production, and processed foods also increases, and urban residents and supermarkets attract more national and media attention to food problems.

There is a growing demand for 'green food' such as organically produced vegetables, fruit, eggs, milk and red meat by discerning buyers. The Green Foods Office within the Ministry of Agriculture estimates that, on average, Green Food attracts a price premium of 15%, but this, at best, a rough indicator. In other countries the premium can be higher. Many supermarkets now have special Green Food counters or areas where discerning buyers can get quality-assured products. The higher income consumers have the primary concerns about food safety and the money to pay for safe food. Around 17% of Green Food products are related to livestock and of these some come from pastoral areas where Green Food certification is easier to manage. Certification of livestock and their products is more difficult in agricultural areas because of the existing high levels of contamination with chemicals, the multiple stages involved, the greater number of specialized producers involved in fattening and the difficulties associated with livestock slaughtering and processing plants that must be located well away from the production areas.

Food safety concerns revolve around hygienic production (not always assured in small-scale feedlots), and processing practices¹⁶. These concerns need to be more seriously addressed if a premium market for meat is to become a reality on a large scale. The Ministry of Agriculture has a purpose-built Food Safety and Quality Center that is charged with managing and coordinating the plethora of industry and company standards that exist for meat products. Only recently has the government moved to reduce the number of administrative bodies having oversight of a single product. Approximately ten government departments and ministries under the State Council monitor food safety in China. These include the Ministry of Health, the State Food and Drug Administration, the State Drug Administration, and the Ministry of Agriculture, the State Administration for Industry and Commerce, the General Administration of Quality Supervision, Inspection, and Quarantine, the Ministry of Commerce, the Ministry of Science and Technology, and the National Institute of Nutrition and Food Safety. No single agency is responsible for all food safety regulations and enforcement in China, and the departments' duties often overlap. By promoting stronger oversight role for the Food and Drug Administration in China urgent reforms to strengthen and streamline inter-agency coordination and enact an overarching

"basic food law" have been announced. There is still a long way to go to overcome the lack of coordination, sophistication and adoption of industry-wide standards.

Food hygiene in processing: In addition to having the raw materials free of contaminants and anti-nutritional compounds there is the matter of safe handling in the transport, markets, slaughter facilities and storage. There is considerable scope for problems to emerge in any one (or all) of these stages and all too frequently they do. Live poultry markets are linked to spread of diseases like SARS and to the Bird flu HN97 that has caused deaths in humans. Markets have been closed in some places and sale of ducks have been banned in others. Slaughtering and processing plants are another source of trouble and salmonella outbreaks and contamination with *E. coli* are commonplace. Storage and transport are weak links in the chain. Animal and fish products are the most vulnerable but dairy products and some fruit processing plants can be sources of unsafe foods.

Genetically modified and transgenic food products: Another concern of the consumer is the potential health risk associated with genetically modified (GM) foods. In some countries the importation and planting of GM crops is banned. In others the advantages conferred by these disease and more resistant plants is embraced. China has 4 million hectares planted with genetically modified (GM) crops, making it one of the world leaders in biotech farming. The main biotech crop in China is cotton, followed by papayas, poplar trees, tomatoes and sweet peppers. GM crops planted by developing countries accounted for 52 percent of the world total, rising 2 percent year on year. Worldwide 10.3 million hectares were planted to GM crops with an increase of 6 percent over the year before. Globally the area planted to GM crops has risen from 1.7 million hectares in 1996 to 170.3 million hectares in 2012. GM crop technology has been adopted faster than any other planting technology in modern history. At present, five kinds of imported crops derived through biotechnology, including soybeans, maize, rapeseed, cotton, and sugar beet, have been approved by the ministry as foreign biotech crops used for processing purposes in China. Not all are approved for commercial-scale production yet.

The issue of GM is controversial and clouded in misconceptions. Most people do not realize that all food plants are genetically modified. It is the work of plant breeder to select various character traits and ensure that these are in the next generation of plant genes. The thickness of the skin on tomatoes, the resistance of wheat to fungal disease, the resistance of potato to virus, the resistance of cotton to boll worm and so on depend on manipulating the genetics. Every rose in the garden has been so manipulated to give the dazzling display of vibrant color, bud shapes, stem length and so on as well as resistance to fungal diseases. Genetic modification of crops differs from conventional, selective plant breeding, a method used since the beginning of agriculture, which crosses plants capable of natural pollination. It is the process of artificially inserting foreign genes into a host plant through genetic engineering to achieve a desired effect. Their release for commercial production is regulated¹⁷. Common genetically modified foods include corn, soybeans, canola and cottonseed oil. What sets so-called GM plants apart is that gene-splicing and other techniques of the molecular biologist have

been employed to insert a particular gene (or several) into the DNA strand to impart a particular trait that already exists in another variant of the plant being improved. That variant may be wild ancestor or from another genus that has, for example high tolerance to salinity from soil or irrigation water. The new configuration in the GM plant allows farmers to reclaim previously abandoned land to produce crops there. In the case of canola, a GM variant of rapeseed that is a major source of cooking oil, the higher resistance to herbicides allows more efficient and cost-effective cropping, thus reducing costs to the consumer.

A fear exists about transgenic modifications that involve taking a gene from another organism (maybe a bacterium or a mouse) and splicing it into DNA of a plant or a farm animal to impart some genetic trait that is novel¹⁸. Transgenic plants can use genes from different species. For example, *Bt* corn uses a gene from a bacterium to produce its own insecticide. This is less likely to be a concern to consumers of food crops or animal products because it is at the experimental stage and not likely to be widely adopted.

Food Waste

As household incomes, urban populations, and overall food consumption in China continue to rise, the country faces serious problems of food waste, natural resource scarcity, and overflowing landfills, but this wastage is not the whole story, about 30–50 percent of the world's food is wasted annually. This includes food lost during harvesting, storage, transportation, and sales, as well as at home. Some of this can be prevented but every citizen can play a part in cutting food waste.

According to the China Agricultural University (2012), 8 million metric tons of food was wasted by catering industry alone in China every year. This is equivalent to nearly 10 percent of the country's annual crop production, or enough to feed 200 million people. In China, \$32 billion worth of food is thrown away every year, as food scraps comprise 70 percent of all waste nationwide. Meanwhile, 128 million Chinese live below the poverty line, and often lack sufficient food. In an attempt to reduce these numbers, China's grassroots Clean Plate Initiative advocates for zero food waste when dining out. As the movement spreads and an increasing number of citizens and organizations join in, more and more people are aware of the issue and willing to act. This is good news and good timing because food wastage on the scale that prevailed for decades cannot be sustained. Yet the story does not stop at dining tables. To make China's agricultural system ultimately sustainable, what grows from the soil needs to return to the soil, by whatever pathway. Reducing food waste by producers and consumers, facilitating municipal food-scrap recycling, and emphasizing the importance of resource conservation can all help make China's food production system more sustainable.

The government of China has decided on the setting of 'red lines' in respect to water and to arable land. These redlines should guarantee that the quantum of both vital resources is assured. If they are adhered to, China has some hope of maintaining food supplies, especially if there is import of food grains as required. The population growth is slowing and now the prediction for 2050 is 1.4-1.5 billion instead of the 1.6 billion that was thought to just a few years ago to be inevitable.

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