Chapter 10
The Main Agricultural Regions of China and the U.S.

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10.1 Introduction

Agriculture defines the way of life of a majority of the residents of the People's Republic of China (China). Over 300 million of the total population of 1.3 billion Chinese are farmers and in total 51.3 % of Chinese lived in rural areas in 2010. Thus a majority of Chinese are impacted by agriculture on a daily basis. China has made great strides in becoming self-sufficient in food and this is particularly true for the three great cereal producing regions considered in this chapter. These are the Northeastern Plain, the North China Plain and the Middle-Lower Yangtze Plain. Benefiting from climate, topography, economic and historical factors, eastern China has become the major agricultural production area in the country. This chapter will focus on the agricultural areas of Eastern China specifically the Northeastern China Plain, Northern China Plain and the Middle-Lower Yangtze Plain. Analyzing the various features of the geographical environment in each area will illustrate the influence of natural conditions on the formation and characteristics of agriculture, of which climate and soil, which are related to each other, are most important. Also included is an analysis of the importance and role of these different agricultural regions in the overall pattern of Chinese agricultural production. The surplus production of grains from these "three storehouses" as well as production of other crops like cotton grown there, provide for the stability of prices and supply in the whole of China and thus are crucial on a global basis.

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While relatively few residents of America (the United States of America, USA or just the U.S.) are farmers they conduct operations on such an extensive and capital and technology intensive scale that the surplus they produce is also a key element in global food security. Only about 960,000 Americans are full time farmers and perhaps another million are farmers, ranchers or fishermen on a part time basis. In contrast to China, only 16% of Americans lived in rural areas in 2010. Chapter 4 discusses the great diversity in agricultural in the U.S. While there are many areas where agricultural surpluses are produced, two stand out in particular. The two great "bread baskets" of the U.S. are the Corn Belt and the Great Plains regions. These two regions that have been blessed by nature with rich soils and adequate water and extensive arable lands and thus produce a great surplus of cereals that in turn are often used to feed animals. Much of the production of both cereals and livestock is exported and these exports are absolutely crucial in global food supply and price stability.

To make full use of the different natural conditions and conform to the development trend of modern agriculture, the production regions in China and the United States both have become specialized. Both of them have successfully built several specialized agricultural zones (districts). China has 16 advantage districts, which include food, economic crops and aquatic products, etc. The Northeast Plain, the North China Plain, and the Middle and Lower Yangtze Plain are respectively production center of corn, wheat and rice. The United States also has several agricultural areas discussed in Chap. 4. These areas include those specializing in corn, wheat, cotton etc. Subject to agricultural production conditions, there are differences, between China and the United States in the key food production regions. The main agricultural production areas of the United States are mainly concentrated in the Middle West, central plains, and west coast states such as California and the Mississippi river basin and southeast coastal region. The major crops are corn, soybeans, wheat, cotton, rice, peanuts and so on. The U.S. agricultural production regions hold a leading position in scale, mechanization, specialization and market-oriented production, and also have high production efficiency. The key food production regions of China are concentrated in the three eastern plain areas. The Northeast China Plain and the North China Plain have been greatly improved in terms of production scale, mechanization and commercialization. Integrated production is the advantage of the Middle and Lower Yangtze Plain. China has comparative advantage in the production and export of labor-intensive agricultural products, such as fruits, vegetables, tea, honey, silk, etc. The United States has a comparative advantage in production and export of land intensive and capital intensive agricultural products, such as soybeans, cotton, corn, wool, chickens, pork, etc. These products all come from the major agricultural production areas discussed in the remainder of the chapter.

10.2 Three Main Agricultural Regions of China

10.2.1 The Northeast Plain

10.2.1.1 Geographical Environment and Agricultural Development

The Northeast Plain is located between 38°46' north latitude to 53°23' north latitude and 115°35′ east longitude 134°33' to east longitude; it mainly consists of three flood plains. In the northeast is the Sanjiang Plain, an alluvial flood plain of the Heilongjiang, Songhuajiang and Ussuri Rivers. South of this is the Liaohe River alluvial plain. In the middle is the Song-Nen plain, an alluvial plain of Songhuajiang River and the Nenjiang River. This agricultural region is located within the boundaries of the provinces of Heilongjiang, Jilin, Liaoning and the eastern portion of the Inner Mongolian Autonomous Region. Its area is approximately 35 million km^2 in extent making this area China's largest collection of alluvial plains. (Cheng 1984; Zhou 2000). The Northeast Plain has only a short history of large-scale agricultural cultivation. Before the nineteenth century, only the Liao River Plain had scattered development. After 1860, the Qing government adopted an "open door" policy which encouraged immigration, resulting in a more rapid development of land in the Northeast. Compared to Liaoning, and Jilin provinces, the development of Heilongjiang province came even later. Before 1904, there were prohibitions on land development. The cold and wet climate is the main reason for the later development of this region. The Northeastern winter is very cold and snow remains late into the spring. The summer is mild and humid, but very short. There is a short growing season and high potential for frost damage to crops. However, the climate also brings adequate precipitation and there is an extensive river system with an abundant supply of water. The cold and wet climate means that the area has nearly 3–6 months of freezing weather and widely distributed frozen soil. Saturated soils and wetlands are very common. There are reed swamps in the Songnen Plain, and seasonal marshes in the Song-Nen Plain. Until the 1950s, the Songnen Plain and the Northern Song-Nen Plain were a "Great Northern Wilderness". (Hao 2010).

However, the area has many advantages for agricultural development. Climatic conditions can produce a one-year maturity, and summer precipitation is concentrated during the growing season. The flat and extensive land area is very suitable for agricultural mechanization. Moreover, the soil is very fertile and distributed widely. The widespread black land soils, also known as Chernozems (Russian) or Mollisols (U.S. soil order) and meadow soils, are rich in organic matter (humus) and have a deep, dark colored topsoil horizon. In the middle of the Song-Nen Plain are the most fertile black land soils of the northeastern zone (Fig. 10.1), which is also the only large black land soil belt in Eastern Asia, with a total area of about 11 million hectare. In natural conditions, the black land soil has 1 m humus layer and rich nutrient availability (high cation exchange capacity). Therefore, after the 1950s, the government invested the labor of hundreds of millions of person years of work mostly by soldiers and urban young intellectuals to reclaim the "waste land" in

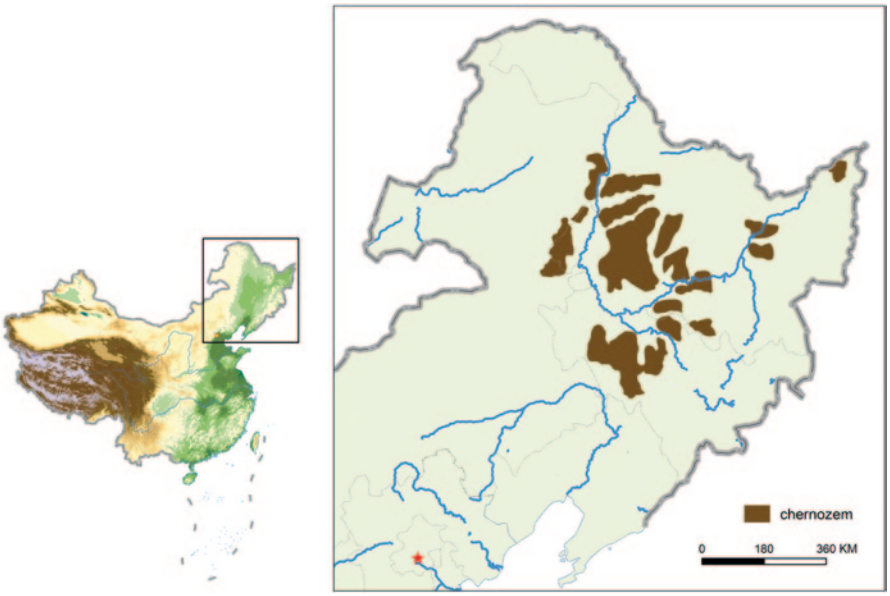

Fig. 10.1 The extent of blackland soils in the Northeastern Region

the Northeastern region and make it suitable for farming. With the development of industry and a transportation network in the Northeast, the level of agricultural mechanization advanced quickly. The cultivated land area and the grain output increased rapidly and the whole region turned into a "big barn". (Li 1993; Chinese Academy of Sciences, Institute of Soil and Water Conservation 1961).

In recent years, global climate change and warming has become a very important factor in agricultural production because agriculture is very sensitive to climatic factors especially water availability and temperature conditions. The extent of the current climatic warming is not beyond the scope of human adaptability, so global warming, especially the increase in temperatures has produced certain positive impacts on grain production in China, especially in the Northeastern area which in the past at least has been severely affected by freeze damage. The rice yield has increased by 2,574 kg/ha due to the warming trend from the 1970s to the 1990s in Heilongjiang province, the estimated contribution of warming to this increase in yield is 19.5–24.3 %. With the agricultural production mechanisms well developed there, the "big barn" status of the Northeastern plain has been consolidated and has improved constantly, but at the same time, a series of ecological problems have been generated, including water consumption, contamination and soil loss, especially the erosion of blackland soils which is mostly due to water.

After being reclaimed, the black land soils became more vulnerable to water and wind erosion, resulting in the thinning of black land soils and a decrease in humus content. The annual loss of black land soils is 0.4–0.5 cm annually in areas with serious soil erosion. In these areas, about two fifths of the black land soils humus

layer is less than 30 cm thick at present. Thus, concurrent with the development of agriculture in this area, a black land soil protection project has been actively carried out. Major measures include: change of the traditional farming methods, plowing along the contour; using no-till practices and returning crop stubble to the soil. Also establishing a scientific crop rotation system in the black land soils; and implementing a system of repair and conservation of forest belts. In addition, the practice of conversion of wetlands into farmland by bog and swamp drainage has also been curbed. Starting in the 1990s, these conservation measures have shifted the focus from maximum output of crops to the conservation of biodiversity and wetland ecology.

10.2.1.2 The Characteristics and Location of the Main Grain Producing Areas in the Northeast

Based on the combination of sunlight, warmth and moisture conditions in the Northeast Plain, most of region can meet the needs of late-maturing and thermophilic crops. In this area, wheat, soybeans and early or middle-maturing corn, rice, sugar beets, and flax are the dominant crops. The cultivation system has a one-year maturity. South of the Liaohe River Plain, winter wheat, and also inter-cropping or multiple cropping varieties of early maturity crops and pasture after winter wheat are dominant patterns. At present, the most optimal pattern of food crops in the Northeast, is a system of tridimensional inter-cropping of spring wheat and corn, or beans and corn, or corn and potatoes. (Sun 2003).

Construction of the Commodity Grain Base and the Operation of State-Owned Farms The per capita food production of the Northeastern Plain is the highest among China's agricultural areas. The region provides a large quantity of cereal grain and soybeans to the country every year. The total arable area of the region accounts for 17.6% of the country's total arable land. The annual grain output accounts about 17% of the country's total output, soybean production accounts for 40% of the country's output, the food commodity rate is 40%, nearly 5% higher than the national average. After satisfying local demand, the food surplus always has been sent to outside regions. The Northeast Plain is an important national strategic reserve grain base, providing stabilization of prices.

Large state-owned farms have played an important role in the process of building the Northeastern agricultural base. The Heilongjiang Reclamation Area, for example, has the largest group of state-owned farms (114 farms under State ownership). In the past 60 years of development and construction, the Heilongjiang Reclamation Area had produced 243.4 billion kg of grain, of that total about 183.65 billion kg entered the commodity markets. Currently, the Heilongjiang reclamation area produces one third of the total food production for the province, using only about one-fifth of the arable land in the province, of which the commodity grain producing area accounts for about half of the province. About 25% of the grain production is sent out of the province into inter-provincial trade, although most is used for

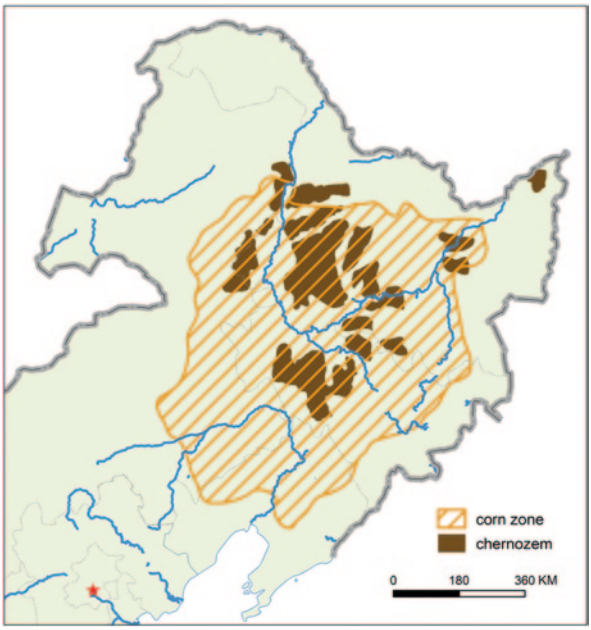

Fig. 10.2 The Northeastern Plain Corn area

domestic consumption in China. In 2010, total grain output of the Heilongjiang Reclamation Area reached 18.2 billion kg, about 17 billion kg of which was grain sold as a commodity. This means that 93 % of production went into commodity markets. The level of agricultural mechanization has reached or exceeded the level common in developed countries. Average annual grain output reached 35.4 metric tons per year per person, the comprehensive mechanization rate is above 93.3 %, of which use of mechanization in dry land farming was about 95 %, and use of mechanization in paddy field (irrigated) agriculture was about 90 %. The Reclamation area also provides services such as tractors and combines to outside areas. (Li 1988).

The Production Centers of Corn and Soybeans Agronomic conditions for corn planting in the Northeastern region are similar to those in the U.S. Corn Belt (described below). Suitable climate and soil conditions all promote corn production. As a result corn yields made up to 6 metric t per hectare or more.

Corn is produced in the northeast of China, in the north of China and in the southwestern portion of China. Of these areas the northeast has the most concentrated production. Jilin Province is one of the world's three golden corn belts (Fig. 10.2). During the past two or three decades, the proportion of grain used for feed and for industrial purposes such as for high fructose corn syrup production has increased, and corn production acreage has gradually expanded. It has increased the fastest in Northeastern China, and it has substituted for sorghum, millet and other low-yielding crops. In 2009, corn acreage accounted for 28.6 % of the agricultural acreage in the country and 42.2 % of the Northeastern region's total crop planting area; production was 46.933 million metric tons in that year, this accounted for 28.6 % of

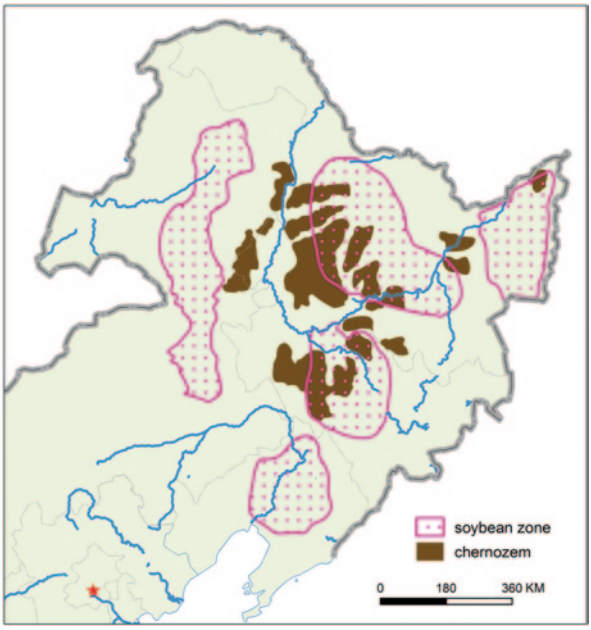

Fig. 10.3 Soybean production & blackland soils of the North-East Plain

the country's total production and 56% of the region's total grain output. (National Bureau of Statistics of China 2010a, b).

The Northeast has a long history of soybean cultivation. Soybeans are an integral part of Chinese culture and diet with soy sauce and soybean curd finding their way into many typical Chinese foods. The Northeast has intensively cultivated soybean acreage (see Fig.10.3), and soybeans are also an ideal rotational crop. There is great demand in export markets like Japan and in industrial applications such as soy sauce and soybean oil production. Soybean production in the region accounts for about 40% of the country's total. Harbin, Liaoning and Changchun city are known as the "three soybean warehouses" of China. Soybean commodity rates (the proportion of production in an area going to markets as opposed to being used on the farm itself) are generally 75–80%, the export rate can be up to 50% or more. With such high production and a high proportion going into export markets, the high quality soybeans from this region are renowned internationally. The total soybean exports of the Northeast accounts for about 37% of the country's total (Fig. 10.4). This graph shows growing soybean exports through 2004 and then a leveling off of exports as China's internal demand has grown. It also shows that other areas of China are starting to account for more soybean exports, but that the Northeast is still important. Soybeans from the Northeast are exported to Korea, Japan, other Asian nations and countries of the European Union. (Liao 2007) (National Bureau of Statistics of China 2010a).

Comparing soybean production in Northeastern China with that in the U.S., the U.S. has advantages in soybean production scale (extent of farms), has higher labor

Fig. 10.4 Soybean exports of the Northeast and the proportion of the country's total

productivity, and about 15% lower production costs than in Heilongjiang Province. The Northeast is not as active in the extraction of soybean oil for purposes of commodity markets. However, in the Northeast such as Heilongjiang, the soy protein content of the soybeans is higher than in the U.S., so soy protein extraction and processing is a very promising field. Industrialization of soybean derived products is a huge global market with great profit potential.

Special Agriculture and Animal Husbandry Products Northeast China is the main wheat producing region in China, accounting for about 50% of the country's total spring wheat planting acreage and nearly 40% of the total wheat output. The Sanjiang Plain, the Song-Nen Plain and the Heihe area are the most concentrated wheat growing areas. The Northeast has also developed some economic crops that are specially adapted to local conditions, such as hemp, flax, sugar beets, and sunflowers, which also occupy an important position in the total production picture of the country.

Heilongjiang Province and the western part of Inner Mongolia is one of the top ten pastoral (grazing) regions of China. It contains vast areas of grassland. The region also produces large quantities of other agricultural products such as bran, soybeans, etc. All these factors are conducive to the development of animal husbandry here. This northern portion of this area also has advantages in raising dairy cows, producing milk and milk products (Fig. 10.5).

10.2.2 The North China Plain

10.2.2.1 Geographical Environment and Agricultural Development

The North China Plain is located between 32 and 42°North latitudes. As an alluvial plain of the Yellow River, Huaihe River and Haihe River, it is also known as Huang-

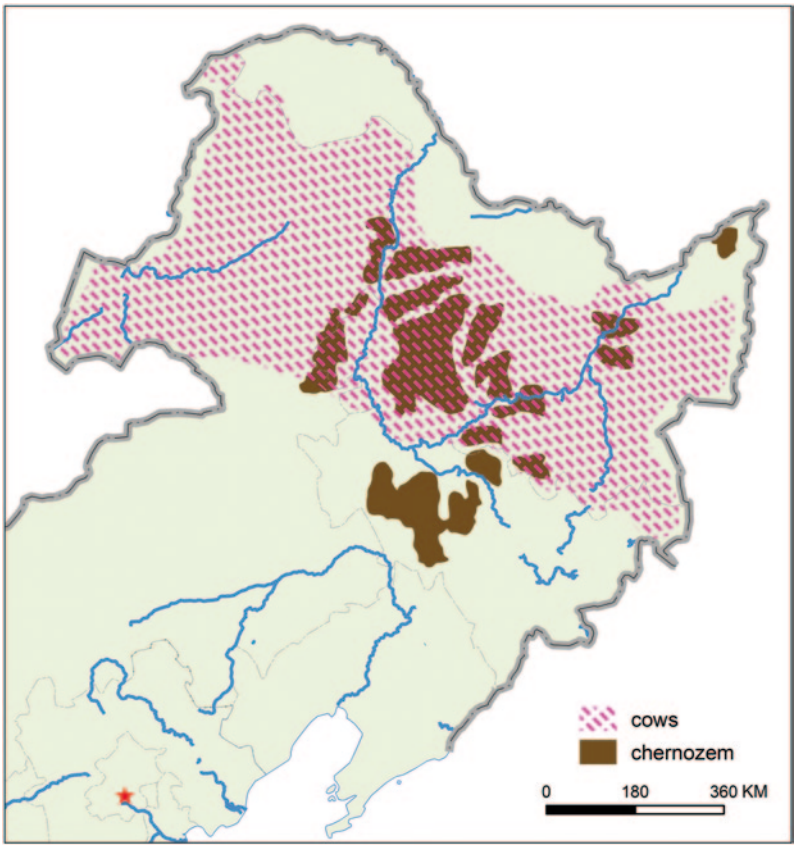

Fig. 10.5 The cattle production area of the Northeast China Plain

Huai-Hai Plain, including the Haihe Plain, Yellow River Flood Plain, Huaibei Plain, etc. It is China's second largest plain with an area of about 310,000 km^2. The region crosses the boundaries of Hebei, Shandong, Henan, Northern Jiangsu and Anhui provinces, and includes Beijing, Tianjin and major cities. The North China Plain is arguably the most ancient agricultural area in the history of China, which has a history of organized agriculture dating back over 3,000 years. China's three "legendary" dynasties the—Xia, Shang and Western Zhou Dynasties, all were founded in different sections of the Yellow River Plain. The North China Plain became the economic and cultural center of ancient China before any other region. This was largely due to the more humid and warmer climate, the friable easily tilled loess (aeolian or wind deposited) soil and good water permeability all of which made for easier cultivation of the alluvial plains. This was coupled with relatively simple dry land farming techniques including the early adoption of simple iron and copper hand tools such as the hoe and spade which predated the use of plows and animal powered implements. (Cheng 1984; Zhou 1993). In the process of development, the North

Table 10.1 Conditions of water resources and its utilization in the North China Plain (National Bureau of Statistics of China 2010)

Region	Total amount of water resources (100 million m^3)	Per capita water resources (m^3/person)	Per hectare water resources (m^3/hectare)
North China Plain	1,990.8	425.3	6,046.3
Total national resources	27,434.3	2,071.1	22,496.9
Proportion of the total (%)	7	21	27

China Plain gave farmers many advantages, low lying and flat land, deep friable alluvial soils, warm humid and semi-humid monsoonal climate—a good combination of sunlight and temperatures, and concentrated warmth and rainfall. The population carrying capacity of dryland farming is limited. However, some historical reasons such as the threat of barbarians and the desire for centralized government control resulted in high-density towns and concentrated population in the North China Plain. Therefore, intensive land use techniques—such as the implementation of crop rotation systems and intercropping systems, were adopted early on to improve the output per unit area, also irrigation was developed to improve crop yields.

In modern times, the North China Plain is a center of political and economic activities (China's capital since 1949 is located here). After the founding of the People's Republic of China, Hebei, Henan and Shandong Provinces, have been designated "agricultural provinces" and they have become a major base of grain and cotton production in China. The role of the agricultural production and processing industry is very important in the area. In 2009, the North China region had 32,925,700 ha under cultivation, and the yield of grain was 191,965,000 t; this accounted for 27% and 36% of the respective totals for the entire country. (National Bureau of Statistics of China 2010). The region is centrally located with respect to transportation infrastructure with railways and highways that all strengthen the North China Plain's position in the distribution and processing of agricultural products. The grain wholesale market in the Zhengzhou area of Henan Province, which is the transport hub of the region, is the "leading grain market" of China. It is also the first market approved by the State Central Food Market, the first trading market to introduce market-based mechanisms of access to both present day sales and the use of commodity futures options. Compared with other parts of the country, the balance of land and water resources is problematic in the North China Plain. There is more land and less water available than in most other agricultural regions. The Huang-Huai-Hai Plain accounts for one quarter of the national arable land and is home to one third of national population, but has access to only 7% of the national total water resources. The total amount of surface water and groundwater are about 2,000 billion m^3. Water resources per unit of cultivated land and per capita are less than 1/3 and 1/4 of the national average respectively (Table 10.1). Coupled with the uneven spatial and temporal distribution of water resources, a serious shortage of water resources exists in the North China Plain. The region shows the effects of global climate change and warming and has experienced a drying trend during the

Table 10.2 Contrasting farmland investment and infrastructure of three agricultural regions (National Bureau of Statistics of China 2010)

Region	Cultivated land (1,000 ha)	Number of units of agricultural machinery per 1,000 ha	Consumption of chemical fertilizer per hectare (kilograms/hectare)	Irrigated area (1000 ha)	Irrigated area as the proportion of the total area (%)
Northeast Plain	21,450	45	236	6,600	31
North China Plain	32,926	31	642	22,347	68
The Middle-Lower Yangtze Plain	14,776	15	781	8,560	58
Country as a whole	121,716	29	444	59,261	49

past 50 years. Water availability and quality has become a major agricultural production constraint, particularly serious during the spring planting season (National Bureau of Statistics of China 2010).

Therefore, subjected to drought and salinization (the development of saline-alkali fields), the North China Plain has developed more low-yielding fields, and this has engendered the need to improve irrigation conditions and the reclaim the saline-alkali fields. The active construction of water conservancy facilities such as irrigation canals and reservoirs makes the area standout nationally. This can be seen in (Table 10.2) which shows that about 68% of available farm land is irrigated in the North China Plain compared with 49% nationwide. Regional drought-tolerance is very strong. However, the irrigation water comes mainly from groundwater. The development of irrigation based on over-draft of groundwater aquifers may cause a series of negative eco-environmental impacts, such as a decline in the water table or the peizometric head in confined aquifers, which in turn increases pumping costs and lowers water quality usually due to an increase in salinity as deeper more mineralized water is tapped. Other issues related to groundwater overdraft include the creation of cones of depression, surface subsidence and faulting, seawater intrusion in coastal areas and the loss of flow in springs with both ecological and cultural significance.

10.2.2.2 The Characteristics and Geographic Setting of the North China Plain

In the North China Plain, the main food crops are wheat, corn, and soybeans. The main cash crops are cotton, peanuts, tobacco and sesame. Most areas can meet the temperature and seasonal requirements for a successful harvest three times every 2 years. From north to south, the cropping system changes from harvest once to twice every year. The multiple crop index is high, about 150% of the national average. (Zhou 2000).

The region that can only sustain harvests three times every 2 years is mainly in the areas with general agricultural conditions and low production levels, such as the Haihe Plain, Shandong and Henan Mountains regions. The crop rotation system is mainly: wheat—cotton—wheat, wheat—soybeans—wheat and wheat—corn—wheat. The region that can sustain harvests two times every year is mainly in areas with better moisture and temperature conditions, such as the Huang-Huai Plain, and the Shandong hills area. The crop rotation system in the cereal crop dominated areas is: wheat—corn, wheat—millet, wheat—soybeans; in cotton dominated areas, it is: cotton—wheat, cotton—potatos; in oilseed dominated areas it is: peanuts—sweet potatoes. In recent years, with the improvement of agricultural production conditions, the double cropping area has expanded each year. The region that can sustain only one harvest per year is mainly in northern and mountain regions with poor agricultural conditions. In these areas the main crops are wheat, cotton, and hemp.

Small Farm Management and Scale Issues in the North China Plain

In the North China Plain and in all other regions of China, a system of household contracts and responsibility for farming was adopted in 1978. Therefore, the main question the development of agricultural resources involves solving is the contradiction between decentralized management at the individual farming family unit level and the benefits that can be derived from adoption of larger scale production methods which require more centralized management.

The North China Plain first achieved large scale production through operations that crossed the region. From the mid-1980s onwards, a group of farm workers that specialized in “plowing, planting, harvesting, and agricultural machinery operation” came into being. Based on the earlier or later maturation of wheat in different regions, these workers moved their operations from south to north. This technique can prolong the season of operations for up to two months or even more. The level of integrated mechanization in the North China Plain exceeds 81 %. The existence of these services combines the benefits of decentralized farm level management and intensive large-scale mechanized production. The wheat reaping technique of using mobile combine harvester teams has transformed thousands of households planting wheat on a small plot into one big farm unit effectively, this makes the scale of agricultural operations and intensivity of wheat production meet or exceed the level of some developed countries, such as France, Germany and the U.K.

In addition to the agricultural product processing enterprises, intermediary companies, and professional associations all play an important role by guiding the farmers in planting activities according to market demand (orders), selection of certain optimal varieties, use of modern technologies and methods and adoption of uniform and appropriate standards. These intermediaries buy the farmers’ grain by list (or orders). All these behaviors turn the scattered small-scale production of individual farming families and small cooperatives into a pattern of “small-scale, large-scale

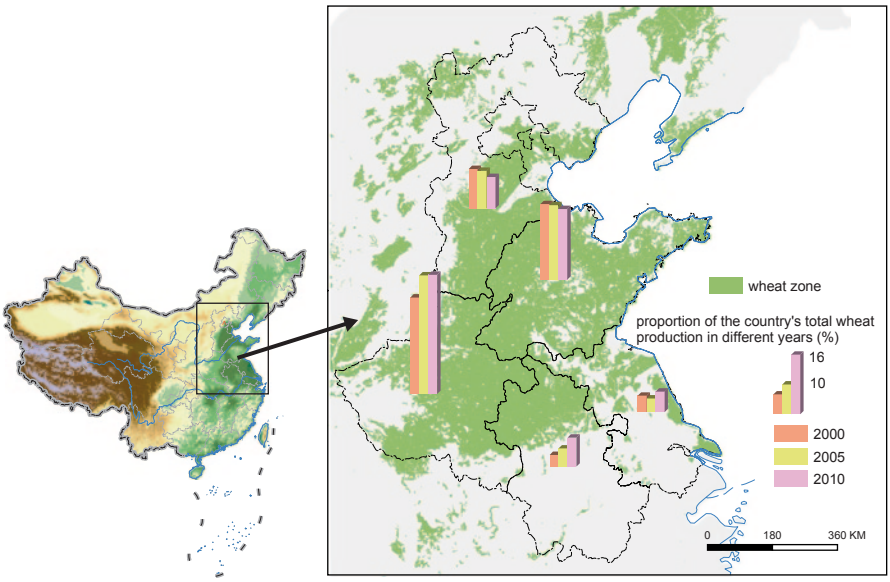

Fig. 10.6 The wheat production areas of North China plain and the proportion by province of China's total wheat production. (National Bureau of Statistics of China 2010)

groups" successfully. The regional government promotes the construction of agricultural industrialization in the form of "enterprise + base + farmers" and "association + base + farmers". In addition to the scattered planting technique, there are various other systems such as some large-scale operations, specialized animal breeding operations, concentrated animal feeding operations, etc. Modernization and intensification are the main development trends in the region.

The Center of Winter Wheat Production

The North China Plain is the most suitable region for winter wheat production in China. Winter wheat is a variety that can overwinter safely under snow in this region and can turn green early in the rapidly warming spring. Moreover, winter wheat is planted in late autumn in fallow fields, which decreases the competition of land and labor with other crops, and also increases the multiple cropping index, and improves the land use rate at the same time. Beside these advantages, the planting time avoids the early autumn floods, which has a positive effect in the stable production of food by avoiding soil erosion due to tillage during wet conditions when rills are likely to form and top soil erodes (Zhou 2000). Therefore, the North China Plain is China's main wheat producing region (Fig. 10.6). With the expansion of the area of irrigated land, soybean, sorghum, millet and other drought-resistant crops have been substituted by wheat gradually. With the promotion and application of advanced cultivation methods, fertilizers and seeds, especially the rotation of wheat

and cotton or wheat and corn, the harvest times of wheat have changed from the situation in the past where it was only once per year or three times every 2 years to the situation now where two crops are raised per year or five crops are produced every 3 years. With the multiple cropping index increasing, grain and cotton both get harvested in this region, and the region has become an important production base of grain. The region's wheat production accounts for more than 70% of the total output of wheat for China as a whole and per unit yield is also higher than the national average (Zhao and Chen 1999).

Special Agricultural Products of the North China Plain

The primary cash crop in the North China Plain is cotton. The North China Plain is ideal for cotton since it has abundant sunlight, adequate moisture and a good temperature regime during the growing season. Hence it is the most important cotton producing area in China. In 2009, the region's production exceeded 40% of the Nation's total. The local cotton industry has developed rapidly and accounts for a major portion of raw cotton exports to outside regions for use by the textile industry which is in turn the World's largest. Shandong, Henan and Hebei provinces are China's major cotton producing provinces. In addition, peanuts, and sesame seed are the main oil crops. As an important producing region of peanuts and sesame, the North China Plain accounts for about 40% of the country's planting area. The main peanut producing regions are Shandong, Shanxi and Henan provinces, and Shandong Province ranks first in peanut production. Sesame production is concentrated in the eastern region of Henan.

The Bohai Sea vegetable farm belt of the North China Plain is one of the four major vegetable production areas in China. The vegetables that are raised in green houses here include melons, beans, celery and leaf vegetables. Shandong Province of the North China Plain is China's main vegetable production province. Large scale, large volume and high technology are its main features. The total vegetable output and its scale in Shandong Province rank the area first among the provinces for 11 years successively. Famous vegetable distribution centers include the cities of Shouguang, Changshan and Jinxiang. The Shouguang area of Shandong Province holds the International Vegetable Sci-tech Fair annually to showcase its use of technology, such as hydroponics. Shouguang city occupies an important position in the national vegetable production. In 2009, the growing area of vegetables in Shandong Province exceeded 1.73 million ha, accounting for 10% of the total vegetable planting area. Annual vegetable production reached 89.372 million t in 2009, accounting for about 14.4% of annual vegetables output of the whole country. (National Bureau of Statistics of China 2010a, b). In order to achieve optimal planned production of crops during the years from 2008 to 2015, the North China Plain has been designated as the National Superior Production Region for beef and sheep. The area can produce forage crops and hay of over 3,860 t per year, providing a strong resource base for the development of livestock feeding. Such obvious advantages, as the existence of convenient transportation facilities, and proximity

to the Beijing-Tianjin-Hebei Megaregion, the "Yangtze River Delta" and the "Bohai Sea" economic circle, have contributed to build a strong marketing foundation and a close connection between production and marketing in this region.

10.2.3 The Middle-Lower Yangtze Plain

10.2.3.1 Geographic Setting and Agricultural Development

The Middle-Lower Yangtze Plain, located between 28 to 33°North latitudes, mainly consists of the middle and lower parts of the Yangtze River flood plain. The Middle Yangtze Plain includes the Jianghan Plain, the Dongting Lake Plain and the Poyang Lake Plain. The Jianghan Plain is an alluvial plain of the Yangtze and Han Rivers, the Dongting Lake Plain is an alluvial plain of the Yangtze River and the Dongting Lake basin; the Poyang Lake Plain is an alluvial plain of the Yangtze River and Poyang Lake basin. The Lower Yangtze Plain includes the coastal plain of the Yangtze River, the Chaohu Plain and the Yangtze River Delta. Compared with the Northeast Plain and the North China Plain, the Middle-Lower Yangtze Plain is fragmented. The provincial boundaries that cross the Middle-Lower Yangtze Plain include those of Hubei, Hunan, Jiangxi, Anhui, Jiangsu, Zhejiang, Shanghai and small parts of other provinces. (Zhou 2000).

The Middle-Lower Yangtze Plain has a long history of human occupation and agriculture spanning about 2000 years. During the late Western Han Dynasty, a large number of people migrated to the south from the Central Plains of China, and promoted the development of the area. The area is humid with a subtropical monsoon dominated climate: hot in the summer and warm in the winter, with abundant rainfall. Sunlight, temperature and moisture conditions are good; rain and warmth come at the same season. All the conditions for agricultural productivity are ideal for multiple cropping and also good for the formation of abundant surface runoff, the development of rich soils and the growth of thermophilic crops. As population pressures have increased, the region has adopted intensive precision farming as its main farming method. Due to numerous and well-designed water conservancy facilities such as irrigation canals and reservoirs built during its long history of agricultural development, the region has becomes the "main paddy field" of China. Here, a wide distribution of rich soils and other agriculturally desirable physical conditions have produced the most concentrated area of paddy soil in China. During long-term flooded conditions, except for an extremely thin oxidized layer at the surface, the whole non-plowed soil profile below the paddy soil is in a reduced condition. High organic matter content will accumulate in such conditions, the soil has excellent water retention and cation exchange capacity characteristics, hence added nutrients are well retained and the solid "plow pan" below the ploughed layer becomes an important basis for superior grain yield. Abundant precipitation and low-lying terrain make for dense river networks and numerous lakes in this area. It is also an important place for freshwater fish farming and fishing. The "five great

Fig. 10.7 Landscape of Yangtze River Plain. Intersecting rivers, widespread lakes and well-developed food production makes it known as the "land of plenty". Inhabitants and agri-cultural production is distributed along the rivers and lakes. An oblique aerial-view of the south bank of the Yangtze River in Jiangxi Province

lakes" inter-connect with the Yangtze River, and also provide a wealth of irrigation water and hydro-electric energy which ensure the stable development of agriculture and supports towns that are an integral part of the base. The region benefited from the opening of the Beijing-Hangzhou Grand Canal, which began to be built in the Spring and Autumn period about 700 BCE and was continued during the Sui, Song and Tang dynasties, and basically completed 1,800 years later in the Yuan dynasty. The well-developed water transport facilities (for barge and sea-going ship traffic), play a very important role in regional trade, exports and food transport. The proximity to excellent transport facilities makes the transportation of agricultural products much easier and less costly in this region than in many other areas of China. (Sun 2003; Tang 1998).

Therefore, once it was initiated, agriculture developed rapidly and it built a solid economic base in the region, this in turn contributed to the development of urbanization and industrialization. So the region has occupied an important position as a national economic center for a long time. Therefore the level of agricultural intensification and comprehensive development of the Yangtze River is the highest in China. The region's rural economy is more highly developed than other rural areas in China. A solid industrial base also provides support for manufacture of fertilizer, pesticides, and to the technology and machinery sectors. Dense urban population and intensive agricultural areas also provide a broad-based market. However, during the past 3 decades, with integrated economic development, especially the growing level of urbanization, prices for potential industrial land have risen dramatically. Farmers have chosen to sell their land and it has been converted to industrial and residential uses. Thus the acreage of agricultural land in the Middle and Lower Yangtze Plain has seen a sharp decrease. The impacts of these changes have caused some of the counties in the region to change from net grain exporters to grain importers. The conflict between use of land for construction of industrial plants and housing and its use for farming has limited the expansion of agriculture in the area.

The agricultural status of the area has declined; however the agriculture of this region still plays an important role on a nationwide basis. (Xu 2002).

The main problems the area is facing are the prevention and control of flooding and drought. In early summer, cold air coming from north can still invade the area and meet the warm air of the south. The month-long period of "plum rains" occur where these air masses meet. This is an important climatic feature of the region. In the summer, typhoons also bring heavy rains. "Plum" rains and typhoons both are an important supplement to the summer rainfall in this area. However, their large variability from year to year may lead to droughts and floods. Areas covered and affected by flood disasters in the past make up about 30% of the country. Therefore, the Yangtze River region needs to focus resources on improving the ecological environment, managing rivers and lakes, strengthening flood control and water conservancy facilities.

10.2.3.2 The Characteristics and Location of the Region

Temperature conditions in the Yangtze River Plain make it possible to achieve two harvests per year in the north and three harvests per year in the south. The southern area is suitable for the growth of a variety of subtropical fruits such as plums, lychees, citrus and navel oranges. The cropping index of the region is very high, it is over 230% in Tai Lake Plain for example.

The Grain Base with the Highest Comprehensive Level

More developed agriculture, higher production levels, and high crop yield per unit area all indicate a high degree of agricultural intensity in the Yangtze River Plain region. As China's most important production area for rice, rapeseed, silk and fish, it is known as the "land of plenty". It is also an important base for the production of commodity grain, cotton and oil (derived from seeds). Rice for human consumption is the main agricultural product and the region also produces other economic crops. The area has outstanding natural conditions for agricultural production in both the northern and southern parts. The cultivation of cash crops has a comprehensive regional character. The region is also China's main producing area for rapeseed and sesame seed, much of which is used for oil production. Most cash crops and food crops are grown in rotation, such as a cotton-wheat rotation, or rice-rapeseed rotation. (Liu 1996).

The Center of Rice Production

The main type of cultivated land in this area are paddy fields used to grow rice, dry lands are also used to grow rice and paddy fields that are converted to and from dry lands depending on the season or other factors are used for rice production as well. The main food crops in the region are rice and wheat, the proportion of rice is larger than wheat. Therefore, rice production plays the leading role in the food production

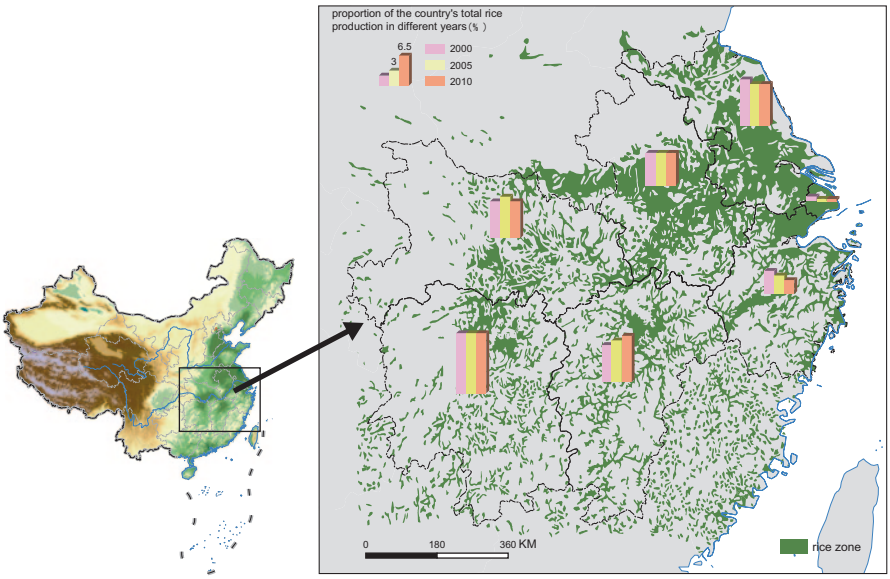

Fig. 10.8 The rice distribution and production in The Middle-Lower Yangtze Plain and its relationship to China's total rice production. (National Bureau of Statistics of China 2010)

of the Yangtze River basin. The cropping system in the region is mainly based on double cropping of rice, the area devoted to double cropping of rice accounts for about 70% or more of the land in the region that grows rice. The total rice planting area of the region accounts for 58% or more of the region's total sown area.

Rice production in the region makes up approximately 42% of the country's total rice production. It is the largest rice producing area and commodity grain production base in China (Fig. 10.8). Hunan, Hubei, Jiangxi and Anhui are all important provinces that contribute to grain price stability in China. The Tai Lake Plain, Jianghan Plain and Dongting Lake Plain, are all areas focused on producing rice. So, they are called the "warehouse of rice". The Yangtze River Delta, with the Tai Lake Plain and the Lixia River plain at the core, is also a famous high yield region for rice production.

Other Crops: Cotton, Silk and Tea

In 2009, the cotton planting area and total production of the region account for 26.5 and 20% of the country's respectively, occupying an important position in China's overall cotton production. China in turn is the number 1 cotton producer on the planet in most years. Hubei and Jiangsu are important cotton-producing provinces, respectively, ranking No. 5, and 7, and are China's highest-yield cotton growing regions. As China's largest hemp producing region, the area's hemp output accounts for nearly 1/3 of the total for the whole country. The main fiber species grown are

hemp, ramie, jute and kenaf. The district's rapeseed and also peanut acreage is very large. It is therefore an important oil production base in China. The northern portion of the Yangtze River Plain is where sesame is more commonly grown. This area accounts for about half of the country's total output.

In addition, the Taihu Lake Basin is one of the three famous silkworm rearing areas, the cocoon production accounts for 56 % of the country's total and China is the world's largest producer of raw silk as well as silk-based textiles. Zhejiang province has throughout history been the main producing area of mulberry bushes used in raising silk worms. The silk industry in the area is long famous and it is known as the "house of silk". Silk has become an important export, with China accounting for 80 % of the world silk trade. The U.S. does not produce silk, and other producers like Japan and Thailand do not have as much land that is suitable for growing mulberry bushes, therefore starting in the last century, the region has become the most important raw silk export as well as silk textile manufacturing center in the world. (National Bureau of Statistics of China 2010b).

This region is also China's most important tea producer. It has large areas of tea plantations. Both the high yield and the extensive area of cultivation help account for half of the county's production. Zhejiang is the most important tea producing province (Hunan is second). In these provinces are the climatic conditions and hill slopes that produce micro-climates and soil conditions that yield many famous varieties of tea, such as Fujian's Yancha tea, Jiangxi's Lushan Mist tea, Zhejiang's Longjing Tea and Jiangxi's Biluochun Tea. China is one of the world's largest tea producers. In 2008, the planting area of tea was 1.258 million ha, accounting for about 43 % of the world total; the tea yield reached 1.275 million t, accounting for about 32.75 % of world tea production. In China, there are about 20 provinces, cities and autonomous regions that produce tea; about 80 million workers are employed in the industry. The tea industry is a major pillar of the rural economy and tea is a symbol of Chinese culture and history. (National Bureau of Statistics of China 2010b).

10.3 Two Major Agricultural Regions of America: The High Plains and The Corn Belt

10.3.1 Introduction

The Corn Belt and High Plains agricultural regions are two of the most important areas in America (the United States of America or U.S.) devoted primarily to agricultural production. Both these huge areas are extensive multi-state regions with rich soils that produce vast surpluses of cereal crops that in turn support sophisticated systems of animal husbandry in modern concentrated animal feeding operations (CAFO's). The main difference between the two regions is a climatic one. The Corn Belt receives considerably more rainfall which in turn makes corn production more feasible on a rain-fed basis. In contrast, the High Plains are considerably

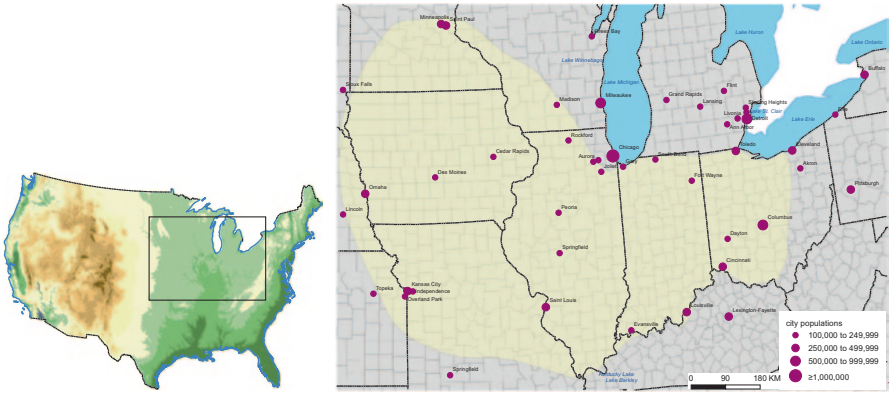

Fig. 10.9 The Corn Belt region with State and county boundaries and major cities

dryer and without irrigation, corn is usually not viable and wheat production is dominant in this region, particularly in those areas without irrigated farmland. With irrigation, other crops including corn but also including cotton are important in the High Plains. While there are many important population centers in the Corn Belt as shown in Fig. 10.9, the density of cities decreases to the west. Chicago, Minneapolis and Cincinnati are all major cities on the edge of the Corn Belt region and serve to move agricultural commodities from the hinterland of the region to global markets. Note that the Corn Belt region has a generally far higher density of farms than surrounding areas (Fig. 10.11). These densities were estimated using a per square mile basis for each county by the U.S. Department of Agriculture Census of Agriculture in 2007. In general, areas with rich soils can support more farms and smaller farms can survive financially. Some mountainous counties have many small farms, so some areas with poor farming do have a high farm density by this measure. For example, in 2009 the average farm size in the State of Iowa (the core of the Corn Belt region) was 331 acres (or about 150 ha). The total number of farms in Iowa was 92,600, these farms produced about $ 24 billion in agricultural products and about 60% of farms were single family farms with farmers living on them. About 12% of Iowa's population was engaged in agriculture in some way, but only about 7% were full time farmers. In the U.S. as a whole, about 2% of the population lives on farms and 1.9% of the population was primarily engaged in agriculture in 2007. In contrast in Oklahoma, a State primarily in the High Plains region, the average farm size was 405 acres and there were a correspondingly lower number of farms, and the value of farm production was slightly less than $ 6 billion. (Economic Research Service USDA 2007). The High Plains region, while larger in size than the Corn Belt, has a much smaller population and most of its major cities are at the edge of the region as shown in Fig. 10.10. There is a scarcity of large cities in the High Plains region with the exception of Denver, Colorado which is on the edge of the region adjacent of the Rocky Mountains that define the western edge of the region.

The average size of farms in the Corn Belt region is smaller than the more extensive nature of farms (and ranches) that are prevalent in the High Plains region. This

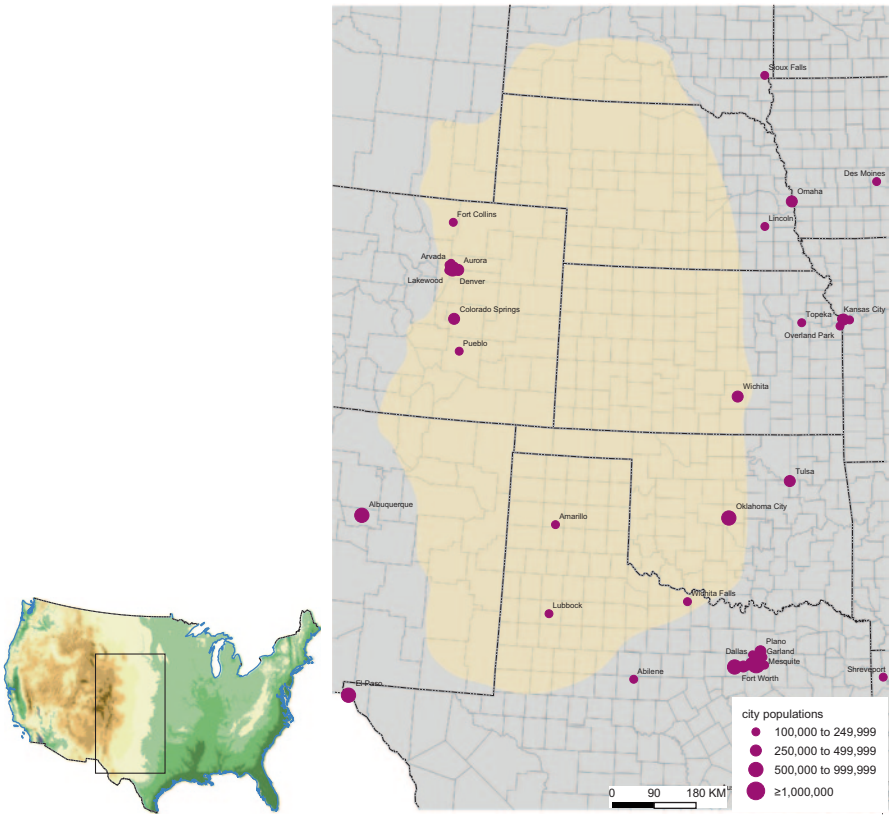

Fig. 10.10 The High Plains region, with State and county boundaries and major cities

difference in the density of farms in the two regions is illustrated in Figs. 10.11 and 10.12. The farm density in the western U.S. is far lower than in the eastern portion of the country, indicating most areas of the High Plains have much larger farms. The drier conditions there require more extensive farming practices, particularly in areas with center pivot irrigation. The exceptions are areas around Lubbock, Texas, and Scotts Bluff, Nebraska where agriculture is more specialized, as well in the Boulder, Colorado area where organic farming is a factor (the largest herbal tea company in the U.S. is headquartered in this county, which has many small herb farms).

10.3.2 The Corn Belt Region

10.3.2.1 Geographical Environment and Agricultural Development

Corn is the most valuable agricultural commodity produced in the U.S. with an estimated value in 2010 of $ 66 billion. In the U.S., corn was raised on 79 million acres

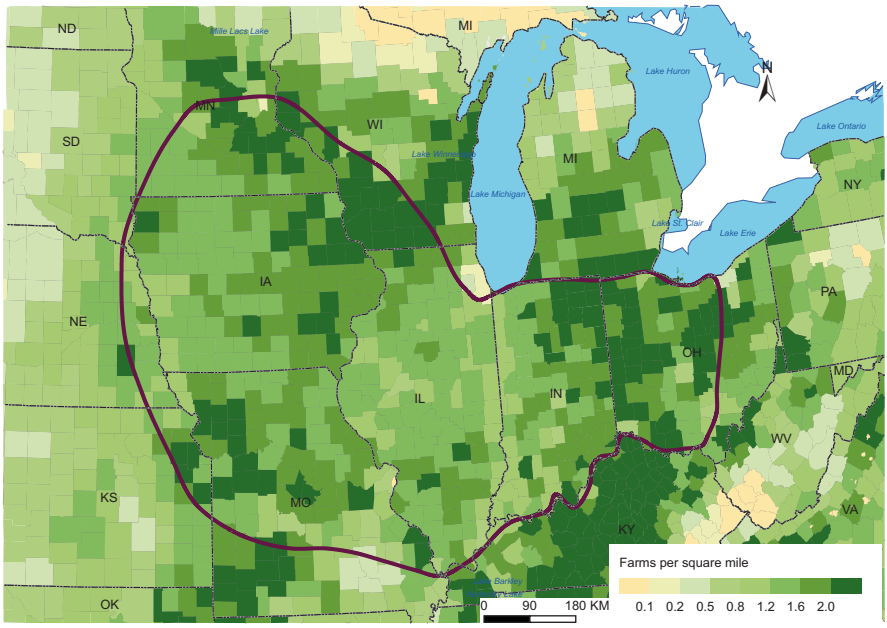

Fig. 10.11 Corn Belt Farm Density. A density of two farms per square mile implies that a farm is 320 acres or 129 ha in extent

(32 million ha) in 2009 (World of Corn 2010). The U.S. is the world's leading corn producer and exporter. In 2010, of 92 million metric t of worldwide corn exports, the U.S. accounted for 50 million metric t. The next largest exporter, Argentina, supplied 15 million metric t. China imported a net 1 million metric t of corn in 2010. Japan imported 16 million metric t and was the largest net importer. (USDA 2010). Corn is used in many ways. These include corn production for human consumption, corn for animal feed (one of the largest uses), and corn for the production of high fructose corn syrup, which is mostly used as a sweetener particularly in carbonated soft drinks like Coca Cola. Corn is also used in the manufacture of ethanol and for many other industrial purposes such as adhesives and plastics. Ethanol from corn includes both the traditional corn whiskey (bourbon) that for hundreds of years was an important way to conserve and trade corn. More recently corn is used for the production of ethanol for motor fuel added to gasoline in mixtures as high as 15% ethanol. The percentage of corn going into ethanol production has been increasing, in 2009 this use accounted for 32% of corn output. However, the price of oil and subsidies for production of fuel grade ethanol has an impact on production levels. While corn is produced in many parts of the United States, including the southeastern coastal plains, the valleys of Appalachia, the High Plains and in the west coast, the region of most concentrated corn production is an area generally referred to as the Corn Belt. This region is centered on the state of Iowa but also includes most of Illinois, and Indiana, the western two thirds of Ohio, southern Minnesota,

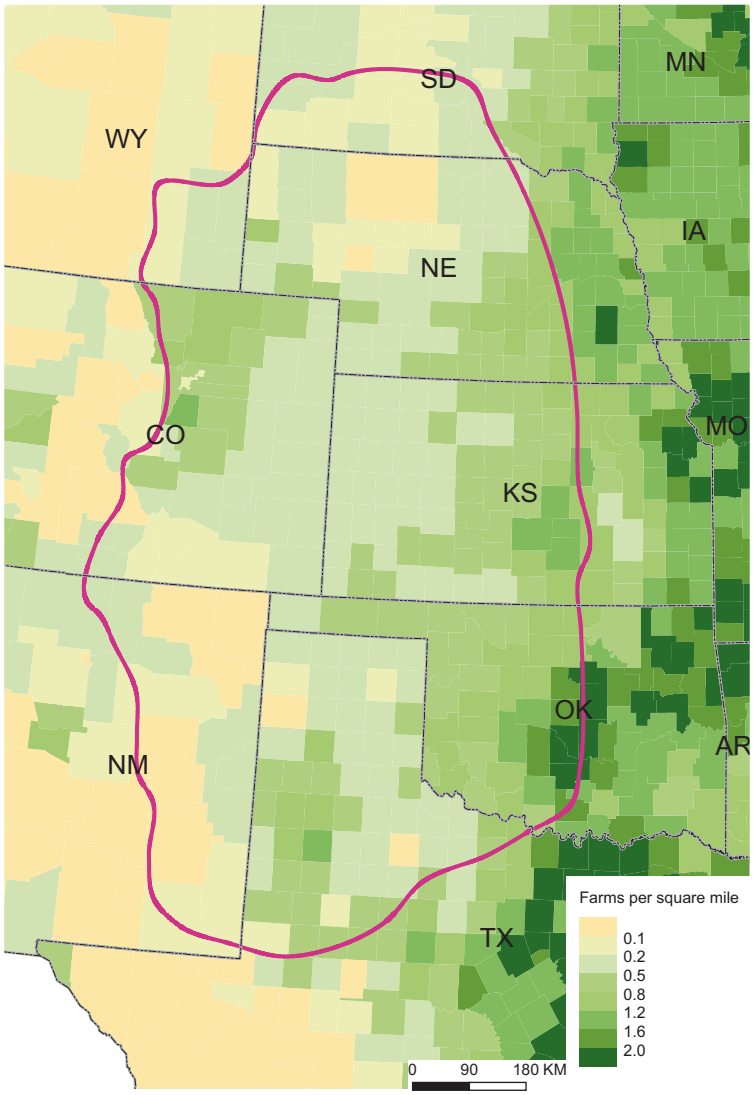

Fig. 10.12 High Plains Farm Density per county. Density is much lower in the High Plains. A Density of 0.1 Farms per square mile means a farm is 6,400 acres (2,591 ha)

most of Missouri and parts of eastern Kansas and Nebraska. This region is defined by climatic factors and geomorphology that supported mostly grassland vegetation and small patches of forest that in turn contributed to the formation of soils that are ideal for corn production.

The Corn Belt has frequent but generally gentle spring, summer and fall rains and winter snows which once supported lush grasslands. But precipitation was generally insufficient to support heavy forests, except along rivers and streams. The

forests that did exist were dominated by deciduous trees. Native Americans also played a role in fostering grasslands by using fire for millennia to clear forests to make hunting easier. The summers are warm and humid but not extremely hot nor dry and the winters are not exceptionally cold nor are they particularly windy. But they are cold enough that organic matter in the soil tends to accumulate under a perennial grass sod. While tornados are more common in the region than in most other parts of the world, they are not as frequent an occurrence as in the High Plains. Blizzards are less frequent in the winter than in the High Plains and dust storms are unknown. However, floods are more frequent than in the High Plains.

The climate of the Corn Belt insures that soil moisture levels and soil temperatures are moderate. These factors tend to encourage an accumulation of organic matter in the form of humic acids. The grasses that thrive in the tall grass prairies of this region cause the formation of deep rich soils, the most typical of which are classified as being mollisol or "black-land" type soils. Similar soils around the world are especially favorable for grain production. Some other areas with similar soils include the Ukrainian and Southern Russian Steppe and the Argentine and Uruguayan Pampas of the delta of the Rio de la Plata. The reasons for the accumulation of organic matter in mollisols are complex, but include such factors as deep root systems of natural vegetation and presence of nitrogen fixing bacteria in root nodules in most clovers and legumes that allow development of soils with good tilth and structure and an excellent cation exchange capacity and high levels of nutrients such as nitrogen and phosphorus (Aydinalp 2003). Thus, mollisols in the Corn Belt are fertile, productive and deep.

The hydrography of the Corn Belt is dominated on the north by the Great Lakes. These lakes include Erie (north of Ohio), Michigan (north and east of Indiana and Illinois) and Superior and Huron (north of Minnesota). The Great Lakes are the largest bodies of fresh water in North America and together hold about 17% of the liquid fresh surface water on the planet (far more water than in all the surface water bodies in China combined). The Great Lakes (Fig. 10.13) are significant economically not as a source of irrigation water, but because of navigation. Ports on the Great Lakes and the major rivers flowing into them allow the export and movement of bulk agricultural commodities that greatly enhanced the value of the surpluses of grain that the Corn Belt generates. For example, in 2010 almost 2 million metric t of grain was trans-shipped from barge to ocean going ships through the ports of the Great Lakes Seaway. Shipment by barges and ocean going freighter is far more economical than any alternative means of transport. This is not to say that rivers are not important also, the Mississippi River is a tremendous highway for barge transport. An extensive series of locks as well as some canals allows grain from the Corn Belt to easily reach the mouth of the river south of New Orleans. Also, canals interconnect the Great lakes and Mississippi River systems and these interconnections are in the heart of the Corn Belt, mostly in Illinois, and much grain transits through the greatest metropolis in the Corn Belt; Chicago. Historically, Chicago's wealth was based on the trade in grain and livestock. Chicago remains the site of the commodity exchanges that set prices on a global basis (Great Lakes Seaway 2010).

Fig. 10.13 Major hydrographic features of Central North America

Most of the water used in farming in the Corn Belt falls as rain or snow, but ground water is abundant and economically important, particularly that water which is extracted from buried valley aquifers. These are alluvial deposits in valleys carved out by glaciers and filled with coarse grained glacial outwash deposits that hold large quantities of high quality water that are essential for large scale agriculture such as swine CAFO's. The buried valley aquifers are numerous in Ohio, Indiana, Iowa and Minnesota and yield purer water than the many rivers that bisect the region flowing towards the Mississippi River or the Great Lakes (Fig. 10.13).

Transportation infrastructure is of greater density in the Corn Belt than the High Plains because population density is far higher. The population center of the United States (lower 48 states) is in the Corn Belt in Missouri, although it has been moving south and west through the Corn Belt for many decades. The State of Ohio has as its motto that it is the "Heart of it all", thus proclaiming the centrality of its location, while Chicago is home of one of the busiest airports in the U.S. and now the headquarters of many airlines and the Boeing Aircraft Company. While the High Plains has been losing population (except in a few energy production-focused areas), the Corn Belt continues to grow in population. The primary transportation infrastructure skirts the Great Lakes passing through hubs like Saint Louis, Chicago, Minneapolis, and west toward Omaha and Dallas.

Land tenure and partitioning patterns are systematic in the Corn Belt due to the prevalence of the Public Land Survey System (PLSS) in the region. As with the High Plains (except for Texas) and other parts of the Western regions of the U.S.,

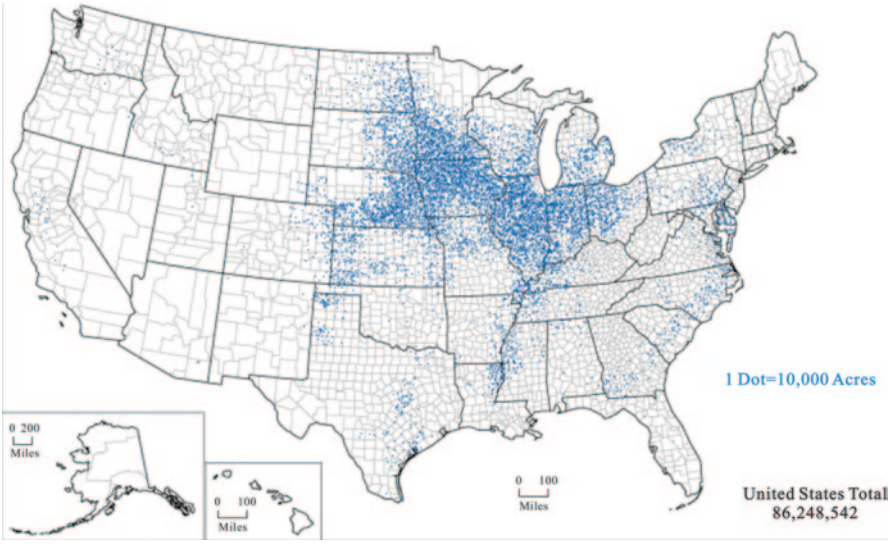

Fig. 10.14 Corn Production for grain based on the 2007 Census of Agriculture, shows the dominance of the "Corn Belt" in production of the most valuable U.S. crop. (Map courtesy of U.S. Department of Agriculture National Agricultural Statistics Service 2007. http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/Fact_Sheets/Geographic/ag_atlas.pdf)

the division of land by the PLSS into a one square mile (640 acre or 214 ha) grid is the dominant land partitioning system present in the region. The great richness of the soil and the reliable rainfall meant that farming was more common than ranching (grazing animals) and that the efficient size of a farm could be 160 acres (53 ha) or less in the Corn Belt. Thus, the numbers of farms of over 1,000 ha are few in the Corn Belt, but farms and ranches of this size or larger are common in the High Plains and many other areas farther west. Also, the towns in the Corn Belt were located not along rail lines, but along rivers, like the cities of Cedar Rapids, Indianapolis and Minneapolis/Saint Paul and where rivers entered the Great Lakes, as in the case of Chicago and Cleveland. In Iowa and surrounding Corn Belt states, small diversified family farms of 160 acres (53 ha) or less became prosperous. The farms in the nineteenth and early twentieth century were diversified. They typically grew corn, had fruit orchards and grew vegetables (mostly for consumption by the farmer or limited barter) and raised cows, swine, chickens, geese and had draft horses. The advent of tractors and farm trucks in the 1920s did not change this pattern much except that draft horses became redundant. Many farmers also added small scale industry such as cheese manufacturing or furniture production, some began to specialize in dairy cattle or swine or just corn. Farm size remained small with adjacent farms being acquired by wealthy farmers, but remaining as family farms. The surplus in wealth generated by moderate sized family-owned farms (See Fig. 10.11) is demonstrated by the fact that Iowa is not only one of the wealthiest U.S. states, but it also has the fairest distribution of income. The Corn Belt region boasts the highest proportion of population with college degrees in the U.S. (Chronicle of Higher Education 2012).

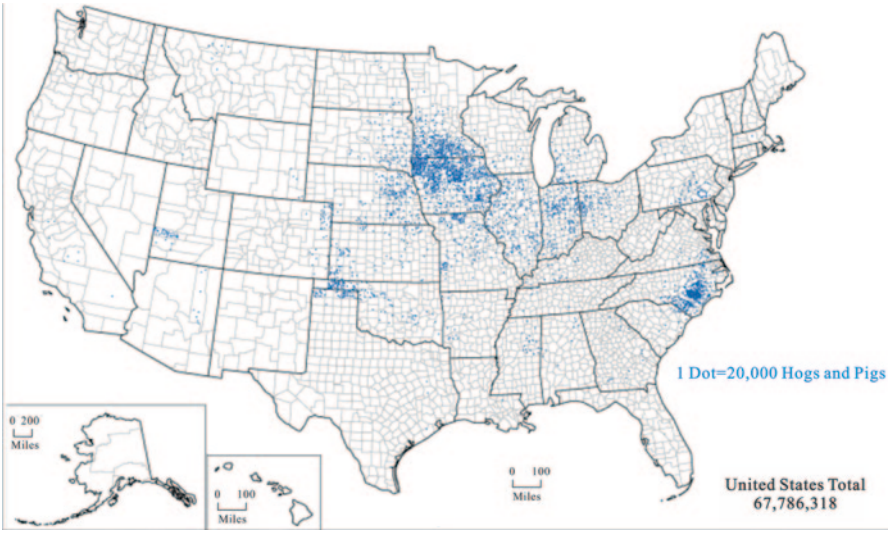

Fig. 10.15 Swine production; each dot represents 20,000 swine. The dominance of the Corn Belt is clear. It shows two other importance areas for swine, one centered in North Carolina and another in the panhandles of Texas and Oklahoma. (Map courtesy of U.S. Department of Agriculture National Agricultural Statistics Service 2007. http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/Fact_Sheets/Geographic/ag_atlas.pdf)

The fact that small family farms can survive and even thrive in a place like Iowa is demonstrated by the success of the Amish. The Amish left Germany in the nineteenth century. They are mostly family farmers and craftsmen making products like furniture. They hold to nineteenth century modes of dress. They also continue to use horses to plow and to pull the wagons and buggies in which they travel. They communally share responsibility for projects like building barns. They are emblematic of the values of hard work and extended family and inter-family cooperation (Hostetler 1993). More recently, large scale production of swine has been attracted to the region by the abundance of corn. Historically, and still today, among the Amish, the farms that raised swine had an enclosed space (sty) where swine could be kept in cold weather and where sows could farrow safely, but most swine spent time outdoors in a pasture. Today most swine are raised in concentrated animal feeding operations (CAFO's).

10.3.2.2 Agricultural Resources of the Corn Belt

Corn

Corn is "King" in the Corn Belt and is primarily raised on family owned farms that, while primarily growing corn, may rotate to other crops as a means of soil conservation and pest control and often have other production of cattle, swine, wheat, or soy beans. In the past, dairy cattle were common in the northern Corn Belt and

Wisconsin cheese is famous. However, since the 1960s, the dairy industry has been shifting away from the northern Corn Belt to less densely populated States of the far west like Oregon, Arizona and Idaho. Thus corn is even more a dominant product in the Corn Belt than in past years. Yields from the best varieties of corn under ideal conditions can exceed 300 bushels per acre (18 metric t per hectare), but in most cases yields of corn are about half that. The average grain yield in Iowa is about 150 bushels of corn per acre (9 metric t per hectare). Note that the bushel is a customary measure of weight of corn in the U.S. and is equivalent to about 40 kg of corn while there are 2.47 acres in a hectare. Iowa is the center of the corn belt (See Fig. 10.11) had over 17 million acres planted in corn in 2010 and the value of the crop was over $ 11 billion in 2010, out of a total value for corn produced in the U.S. of about $ 66 billion nationally in 2010 (ERS-USDA 2010). These production totals for corn far exceed those of any other crop in the U.S., especially in the Corn Belt. Corn is thus by far the most valuable crop and soybeans and wheat have less than half the value of corn production.

Swine

Swine can be viewed as "value added corn". Swine can adjust to being raised in a confined space. This has led to the development over several decades of the Concentrated Animal Feeding Operation (CAFO's). In swine CAFO's, a large barn may contain as many as 2,000 sows. Economies of scale in swine processing (slaughter) mean however that the processing facilities are large centralized facilities and while located in regions containing numerous swine CAFO's they may be more than 100 km distant from the CAFO where the swine was raised. A few firms dominate the swine CAFO business. These include Tyson, Con-Agra, and Seaboard Farms. Usually the swine CAFO is operated on land owned by a farmer and leased from a farmer and the farmer is hired to be manager of the barn. (Pig Process 2009). The system is increasingly export oriented, with large quantities of pork shipped from the U.S. to Japan, for example. The same firms which have developed the swine CAFO industry are building similar farms in many other places, including Mexico, Russia and China.

There are several negative externalities associated with the large scale swine CAFO. One is the potential for water pollution and odor from the liquid waste that swine generate. The waste from swine in the typical CAFO falls through the steel gratings of the floors of each pen into a collection system. Sometimes the waste is stored underground in a concentrated form, more frequently it is piped to an open "lagoon" where it is mixed with more water and rain. This water/animal waste mixture is then typically pumped to center pivot irrigation systems that spray it on crops such as corn that will in turn be feed to the same or other swine. Not all swine in the U.S. reside in the Corn Belt, but in 2009, 29 % were in Iowa, another 11 % were in Minnesota and another 13 % were in Illinois and Indiana together, adding those in other parts of the Corn Belt, the majority of swine in the U.S. were raised in the Corn Belt (Fig. 10.15). Where these animals ended up ultimately was in places often far from the Corn Belt, about 2 million live swine were exported to Mexico in 2008.

10.3.3 The High Plains Agricultural Region

10.3.3.1 Geographical Environment and Agricultural Development

The "High Plains" while something of a term of art, generally refers to a region of the Western United States characterized by relatively high altitude and very flat prairies (steppe type) lands. These are located east of the Rocky Mountains but mostly to the west of the center of the United States (which is located in Kansas). The region includes the "panhandle" of Texas, the western half or more of Oklahoma, and western Kansas, also eastern Colorado, and much of Nebraska; the region also includes parts of South Dakota, north-eastern New Mexico and eastern Wyoming. Altitudes in the region range from 500 to 2,500 m above sea level, higher than average for the U.S. and that along with the flat character of the land accounts for the name High Plains.

The region is characterized by a relatively harsh and extreme weather with hot, dry and windy spring and summer weather and temperatures as high as 40 °C with long dry spells and infrequent but intense thunder storms. The winters are cold and windy with occasional blizzards, but generally have cold and clear days and limited snowfall. Temperatures as low as 40° below zero Celsius are seen, particularly in Wyoming and the far western edge of the region which has higher elevations. The outstanding weather phenomenon of the High Plains is the tornado. More tornadoes occur here than anywhere else on the planet. These intense and often destructive wind storms derive from thunderstorm super cells that are created by the convective mixing of warm moist air that comes up from the Gulf of Mexico to the south that then comes in contact with cold dry air masses funneled down from the arctic along the Rocky Mountains. Tornadoes can have winds in excess of 500 km per hour, the highest on the planet. These storms can be part of outbreaks and can cause millions of dollars in damage. Much of the damage is to agricultural crops and infrastructure, although scores of lives are lost in typical years in tornadoes in the High Plains.

Another feature of the high plains that is significant is the propensity for drought. The region can have prolonged droughts, the most infamous being the "Dust Bowl" of the years 1931–1937. This drought was centered on the southern portion of the region and caused millions of refugees to flee the dust storms and crop failures that occurred. Another drought starting in 2010 caused over $ 10 billion in agricultural (and forestry) losses in Texas alone. Since the 1950s groundwater resources, particularly of the Ogallala aquifer (see Fig. 10.16) have been exploited and this has lessened reliance on rain fed (dry land) farming in the region and made farmers more impervious to droughts. The long term sustainability of the overdraft of this and other aquifers in the region is in question and this in turn imperils the long term economic outlook for the region which in general is seeing a decline in population. Recent development of wind energy in the region is an outgrowth of some of the same factors that made the dust storms of the Dust Bowl period so severe (Worster 2004). Dust storms are a feature of spring weather in many of the southern and western parts of the region. This is something that the region has in common with Northern China. Even when there is not a drought, the region is generally dry with

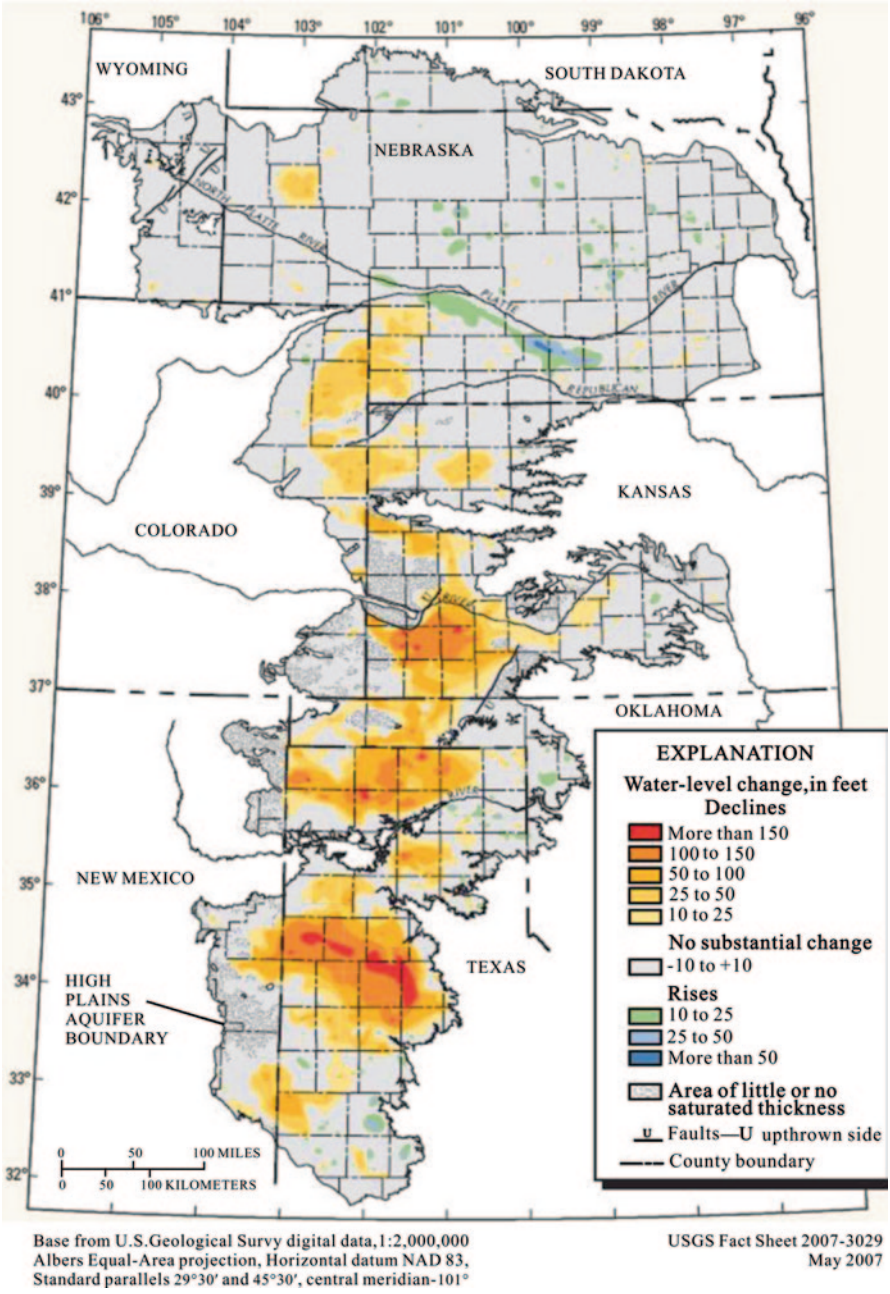

Fig. 10.16 Map of the Ogallala (*High Plains*) Aquifer, the most important regional water source. The aquifer is being over-drafted with draw-downs that exceed 50 m. In Nebraska water availability is large while in the panhandle of Texas, the aquifer is in danger of depletion. (Courtesy: U.S. Geological Survey 2007)

total precipitation ranging from 250 to 500 mm with potential evapotranspiration being significantly higher due to low humidity and frequent wind. Wind erosion control measures such as wind breaks are a feature of the region, although they are less common than in the period immediately after the Dust Bowl. Precipitation lessens from East to West across the High Plains, with snow being more common in the north than south of the region, but low humidity causes a lot of the snow cover to sublimate.

The High Plains are a large area with a diverse range of soils. The most common soils are mollisols developed under the grasslands that dominated the region. These mollisols are however thinner than those common in the Corn Belt. The wind and thinner soils make them prone to erosion and soil conservation is an important issue in the High Plains. Also aeolian soils are present in the region. As with many areas of the North China plain, the High Plains have a considerable region dominated by wind-blown soils. These soils cover many areas of the panhandle of Texas and Eastern New Mexico.

The most important hydrographic feature of the region is invisible except in its effects. It is the Ogallala (and other) aquifers that underlie the region. The water in the aquifer can be considered "fossil" water as it was deposited in deep alluvial sediments fed by ice age glaciers that covered the Rocky Mountains to the West. These glaciers gradually receded over the last 15,000 years and the current recharge of the aquifer from rainfall is negligible. There are however rivers that cross the region. These rivers mostly originate in the Rocky Mountains and the water in them is a valuable commodity and the source of many contentious struggles between various states and private parties. Rivers such as the South Platte, North Platte, Arkansas, Pecos and Canadian cut across portions of the region but do not have adequate flow to satisfy the total demand for water. Since these rivers can be flood prone, flood control reservoirs that also have a water supply function have been constructed on some of the rivers, but the extreme flatness of the high plains means that reservoirs are less than full and have net evaporation, thus they do not conserve water, although they may make water available at times and in places that would not otherwise be the case. (Kromm and White 1992).

Numerous railroads and Interstate highways crisscross the flat High Plains. The High Plains had early access to railroads with the advent of the transcontinental railroad (Union Pacific-Southern Pacific) in the 1860s as well as the Atchison, Topeka and Santa Fe, the Missouri Pacific and other rail lines. The romantic era of the cowboy driving vast herds of cattle across the unfenced High Plains to riotous rail heads like Dodge City, Kansas lived on in memory and movies long after the invention of barbed wire began to close off the open range in the 1870s. The invention of refrigerated rail cars and the growth of a slaughter house industry in cities such as Chicago, Illinois, Omaha, Nebraska and Fort Worth, Texas also were part of a growing and integrated infrastructure. The scientific efficiency (if not the cleanliness) of these early slaughterhouses was famous, they had, it was said, "a use for every part of the pig, but the squeal". This rail and meat processing infrastructure was added to by highways connecting far-flung cities during the twentieth century. These include the Lincoln Highway in 1919 which was the first transcontinental paved highway

and which cut through the High Plains and the more famous and later Route 66 which connected Chicago with Los Angeles cutting through the heart of the High Plains in the 1930s. The Interstate Highway System has superseded these earlier roads and connects all the major economic centers of the High Plains with ports and processing centers.

The Interstate Highway System and rail is the circulatory system of the High Plains and determines the siting of facilities, particularly for grain processing and storage and large-scale cattle feed lots and swine concentrated animal feeding operations (CAFO's). These facilities are a critical component of export-oriented agricultural production (Federal Highway Administration 2010).

In earlier years, many grain elevators and milling and processing facilities were owned by farmer cooperatives. Although many such cooperatives still exist, increasingly, corporate agricultural giants like Cargill, Archer Daniel Midlands (ADM) and ConAgra, JBS and Swift control the processing facilities, particularly loading facilities where grain is shipped by rail, barge and truck to demand centers and for export. One demand center is the large-scale feedlot operations and CAFO's. Cattle feedlots are situated near transportation hubs and calves born and raised on distant ranches throughout the western U.S. are transported to them, typically by truck on State, U.S. and Interstate highways to centralized feedlot operations. At cattle feedlots they are fed cereal grains and gain as much as 500 kg in weight in a few months prior to slaughter. Since shipping full grown steers is harder than transport of calves, most slaughter houses are in close proximity to the concentration of feedlots which in turn are located centrally in the High Plains, although the dryer conditions of the western portion of the High Plains are more favorable for these extensive outdoor operations than the climate further east. The largest of these located in Eastern Colorado has in excess of 100,000 cattle being feed simultaneously.

The history of land tenure in the High Plains is one tied to the issue of land partitioning systems. In most of the U.S., the public land survey system (PLSS) was used to convert lands roamed by nomadic (as well as settled) Native American (Indian) tribes into a regular pattern of farms, and towns and cities. The Federal Government provided land to railroads and to settlers. The land was divided into numerous 1 square mile (640 acre or 300 ha) square sections. Most land was given away to pioneer settlers as part of the Homestead Act which started in 1862 and continued until most land of any agricultural value had been given away, typically before 1890. The Homestead Act provided each pioneer farmer (or rancher) with 160 acres of land at no cost with the requirement that he live on and improve the land before it became his private property. The Federal Government also allocated large areas to the state governments to fund higher education. An exception to this system was Texas which from 1836 to 1845 was an independent republic. When it joined the Union it retained ownership of all (not yet private) lands which at that time was over 100 million acres in extent. These lands included the vast acreage of the Texas panhandle which is an important part of the High Plains. These lands were sold and/or given away by the State of Texas (Nebraska Studies 2009). Over time, the original pattern of a single family farm on each 160 acres began to break down. Unlike in many other parts of the world where in time subdivision of farms in ever

smaller plots took place, in the High Plains the reverse process has taken place. The efficient size of farms in the days prior to the advent of tractors in the 1920 may have been 160 acres, but after the arrival of mechanization, the efficient size of a farm or ranch in the High Plains increased to several times that, usually several thousand acres. Many ranches particularly in Texas and Wyoming far exceeded this size. An extreme case was the XIT Ranch in the Texas High Plains which covered over 3.1 million acres (1.3 million ha) and was the largest private land holding in the U.S. The result of the growing size of ranches and farms was movement of some population to towns in the region, but overall a drop in population in the region as a whole. The growth of CAFOs, cattle feedlot operations and meat processing facilities has also caused a shift in the character of the population, with many Hispanic migrant and seasonal workers taking jobs in these facilities. In the areas of the High Plains outside such centers of intensive meat processing as Guymon, Oklahoma, or Amarillo, Texas, the declining population is both aging and still very much Anglo-Saxon in origin. Some Asian immigrants took up farming in the High Plains, most of these farmers were Japanese immigrant wheat farmers, only a very few Chinese, who had worked originally on the railroads, settled down to farming in the High Plains.

Farming patterns have adjusted both to the larger size of land holdings and the advent of deep wells capable of taping the underlying aquifers. Thus what were exclusively wheat farms supplied with water by the infrequent but intense summer rains and winter blizzards have become more diverse with crops like corn, and cotton also being produced there. Despite growth of these other crops, wheat continues to be the predominant crop in terms of acreage in the High Plains. It has the advantage that it lends itself to production on a vast scale and does not require irrigation. As the aquifers underlying the High Plains continue to be over-drafted, the costs are ever increasing amount of energy needed to pump water from aquifers with a declining pressure head. Many High Plains operations are "farm-ranches". This region has its more fertile areas devoted to crops like corn in rotation, some farms may have orchards in limited areas, some may grow oats or barley, but most of the land is devoted to either wheat or pasture for cattle. These diversified operations of a farm-ranch give its owners the flexibility to raise crops and livestock and cereals to meet various market conditions. This is not so much a matter of being self-sufficient, as in mixed farms in the past, as all of the operations are on a scale that far exceeds the needs of the few workers involved. The diversification is more a matter of taking advantage of the character of the land on an extensive holding to produce the crop that is most suited to that portion of the farm-ranch and to be able to take advantage of different market conditions such as an increase in corn prices in one year and a drop in wheat demand at another time. Of course, there are other patterns with some areas with poorer soil, colder weather or dryer conditions (or all three, as in Wyoming) being devoted solely to grazing with areas with richer soils, more moisture and warmer winter temperatures such as Deaf Smith County, Texas or central Kansas growing corn more frequently.

A contrast between the Corn Belt and High Plains is provided by the farming statistics for Wyoming. In 2007 Wyoming had only 11,000 farms (mostly cattle ranches

or mixed wheat and cattle "farm ranches"). The average size of these ranches was 1,470 ha. Many of the ranches were even larger, with 27% being over 2,000 ha in size. In spite of their vast size, many of these ranches are owned by a single family and with seasonal migratory labor and help of cowboys they often are operated by an individual man and woman and their immediate family. The 11,000 farms and ranches in Wyoming held 732,883 cattle in 2007. (Economic Research Service, USDA 2007). This great extent is in sharp contrast to the situation in a State like Iowa, where the average farm is about 134 ha in extent. The average farm in China is about 1 ha (or slightly less) compared to about 175 ha in the U.S. in 2007, but in areas with climates similar to the High Plains, particularly the higher elevation portions of the region like Wyoming, the size of farms and ranches (grazing lands) is correspondingly larger and areas like Inner Mongolia or Tibet might approximate the average farm (ranch) size in cold arid regions of the High Plains. Wyoming is not a top cattle producing State, but the five leading beef cattle producing states in 2007 were Texas, Kansas, California, Nebraska, and Oklahoma in that order. California is not in the High Plains region but the other 4 states are. All of these four States extend outside the High Plains, but some of the best cattle raising areas in these states are in the High Plains region.

10.3.3.2 Agricultural Resources of the High Plains Region

Wheat

Wheat is gown in many parts of the U.S., but the High Plains are particularly important (Fig. 10.17). Wheat is the crop that the High Plains have been most known for since the later part of the nineteenth century. The rich loamy soils formed over millennium by grassland vegetation and the flat expanse of the High Plains lent itself to wheat farming once plows that could turn the thick heavy sun hardened sod and reapers that could harvest wheat on a large scale were invented by John Deere and Cyrus McCormick respectively. Tractors and combines further mechanized the process of wheat planting and harvesting. The most common wheat grown in the High Plains were varieties of wheat like "Turkey Red" and hard red winter wheat. Wheat yields per acre are actually lower in the High Plains than for the U.S. as a whole, but the extent of farms and the ease of harvesting vast flat acreages more than compensates for lower than average yields. For example, in the Texas portion of the High Plains, average yields are about 35 bushels per acre (about 400 kg per hectare), compared to a national average of 46 bushels per acre in 2010. Texas wheat production, which is mostly from the High Plains, was estimated at 122.5 million bushels in 2010, up from 61.3 million bushels in 2009. Harvested acreage for wheat in Texas, at 3.5 million acres in 2010, was up 43% from 2009. Other States in the High Plains region had winter wheat production that totaled 1.48 billion bushels in 2010. Irrigation can significantly increase wheat production in the High Plains. Typically, irrigation doubles wheat yields in the High Plains. As a result over 1 million ha of irrigated wheat was raised in the High Plains of Texas alone in 2009 (Fig. 10.18). (National Agricultural Statistics Service 2010).

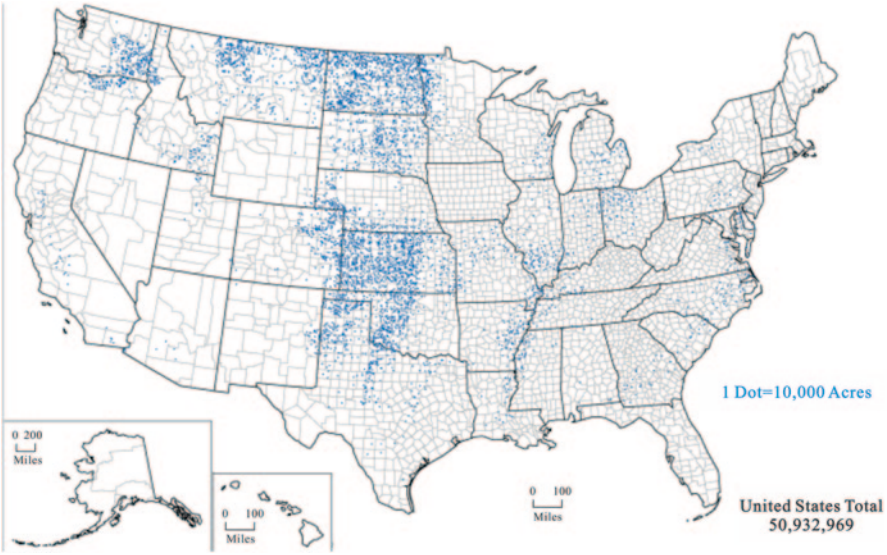

Fig. 10.17 Map of wheat production in 2007. Each dot represents 10,000 acres of wheat. Note that the High Plains, particularly Kansas, North Dakota and Eastern Washington have the highest concentration of wheat farms. However, the yield per acre is higher in some of the southern areas, particularly when irrigated. (Map courtesy of U.S. Department of Agriculture National Agricultural Statistics Service 2007. http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/Fact_Sheets/Geographic/ag_atlas.pdf)

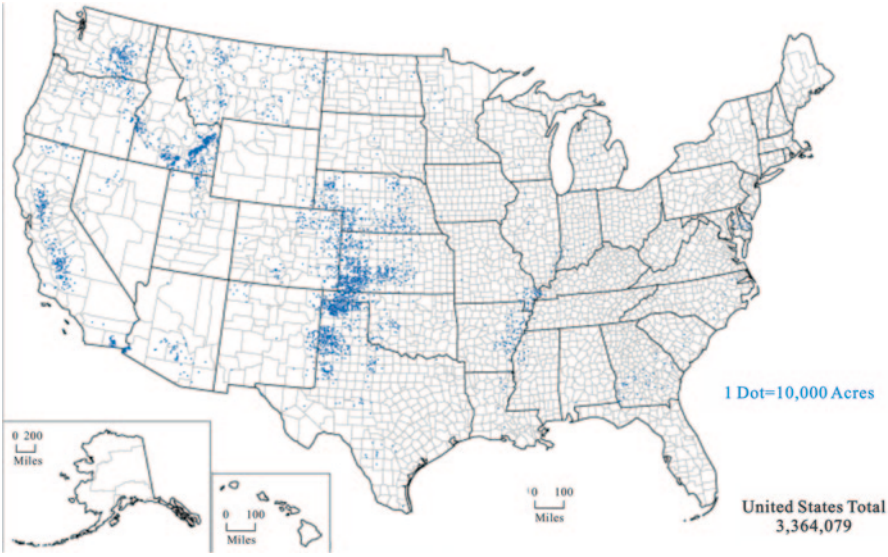

Fig. 10.18 Map of irrigated wheat farms by county in 2007. Note that each dot corresponds to 10,000 acres of irrigated wheat. Irrigating wheat is a common practice in parts of the High Plains, & Idaho including some of the most productive counties of the panhandle of Texas. (Map courtesy of U.S. Department of Agriculture National Agricultural Statistics Service 2007. http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/Fact_Sheets/Geographic/ag_atlas.pdf)

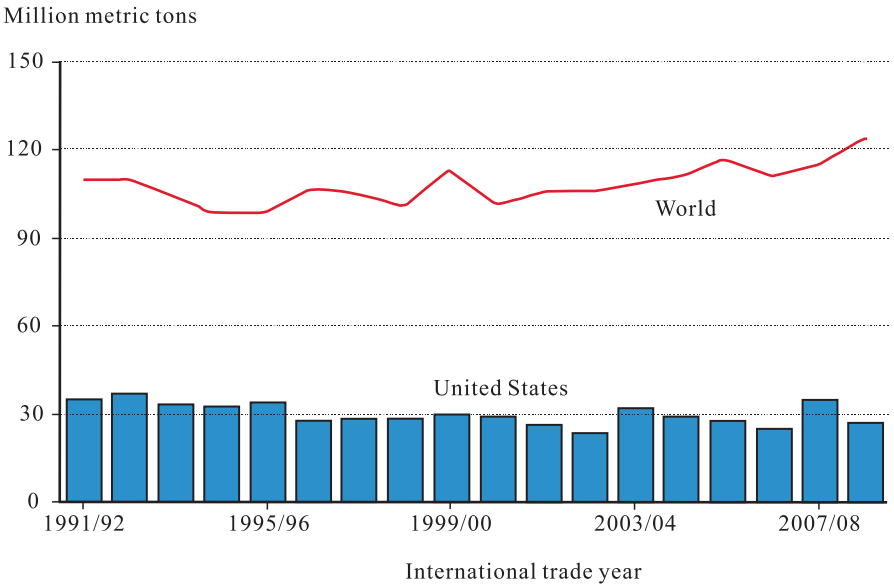

Fig. 10.19 Graph of U.S. wheat production versus total world wheat production. U.S. wheat production has been close to 30 million metric t per year. The U.S. is the world's leading wheat exporter, China produced more wheat than the U.S. recently, and this meets internal demand. (Courtesy U. S. Department of Agriculture Economic Research Service Foreign Agricultural Service 2010)

Harvesting is often carried out by roving teams of contractors that move fleets of combine harvesters from farm to farm. The system depends on the date when wheat is ready to harvest, being earlier in the southern part of the High Plains and then later in the season farther north. A similar system is used in China and is described earlier in this chapter. The U.S. is a major source of wheat for world food security. The chart in Fig. 10.19 shows the U.S. contribution to world wheat production. The U.S. top export markets for wheat include the nations of Nigeria, Egypt, and Mexico, but at present China is not a major destination for U.S. wheat exports, because China is self-sufficient in wheat production. However, many areas of the developing world are dependent on U.S. wheat production and U.S. production has an important impact on world prices.

Cattle

Raising cattle in this area predates wheat production in the High Plains. Cattle were introduced into Texas by the Spanish in the seventeenth century and by the period of the Civil War (1861–1865), vast herds of more than one million half-domesticated longhorn cattle ranged throughout Texas. These were driven by the legendary cowboys to rail heads in places like Dodge City, Kansas and Cheyenne, Wyoming to be loaded onto rail cars, typically for shipment to slaughterhouses in places like

Omaha, Nebraska and Chicago, Illinois. Today there are many vast cattle ranches in the Western U.S. including throughout the High Plains, but the typical pattern does not involve raising cattle from birth to slaughter in the High Plains, but involves bringing calves raised in family-owned "cow-calf" operations throughout the Western U.S. to nearby auction barns throughout the region. At these auctions buyers bid on the calves and the calves are then shipped to feedlot operations, frequently located in the High Plains, where they are fed intensively with grain brought from closer at hand than the cattle themselves. The system is driven by logistical factors. The weight of the feed a steer eats at a feedlot is perhaps 100 times the weight that the steer gains. It costs much more to ship the grain used than the calf. Thus the feedlot should optimally be located closer to the areas of surplus grain production and along a rail line (or better yet near the junction of several rail lines). (McLachlan, 2008). An example of such a centralized and optimally located facility is the "Five Rivers" cattle feedlot in Greely, Colorado in 2012 owned by Brazilian agricultural conglomerate JBS. It holds approximately 120,000 cattle at any given time. It is located in the northwestern periphery of the High Plains, so it can draw grain from the areas to the south and east and cattle from areas that are less productive for grain but can still support cattle ranching to the north and west. Calves are shipped to this facility from as far away as Nevada and Oregon, adding to many that come from the mountains and valleys of the Rocky Mountains region as well as the High Plains itself. Raising a calf requires considerable space and grazing land, but not necessarily the lands with the richest soils. It is better to raise the calves in other areas such as Montana, New Mexico or East Texas not otherwise as suitable for crop production or large scale grain production as the heart of the High Plains and ship the calves hundreds or even thousands of kilometers in a large truck over modern highways and/or by rail to the feed lot operation (Fig. 10.20).

Of course not all cattle are raised on feed lots, there are numerous dairy cattle operations in the region, many of these farms are cooperatives which share milk processing facilities. There are also an increasing number of organic dairies with organic milk fetching a premium price (California Farmer 2010). Dairy cattle are likely to be in areas with richer grasslands and are not moved as far as the vast distances that meat cattle travel in the modern integrated operations found in the High Plains. Traditionally, the Hereford breed has been dominant in meat cattle production, but the Black Angus and various cross breeds are becoming more popular, perhaps because of higher quality meat. The preferences of consumers in a global market for beef have had some effect on cattle production choices, with some producers starting to produce Wagu and other premium oriental varieties of beef for export to Japan and South Korea. While corn-fed dry aged beef from such areas as the Omaha, Nebraska region has long been considered a premium product, grass fed oriental breeds like the Wagu command a much higher price and are becoming more commonly raised. Also beef from this breed is starting to be demanded by gourmets in the U.S., not only in Japan and Korea.

Cattle are used to produce both dairy products (milk and cheese) as well as meat, but dairy cattle are raised on different types of farms and using different systems than beef cattle. Wisconsin, a state partly in the Corn Belt and California are the

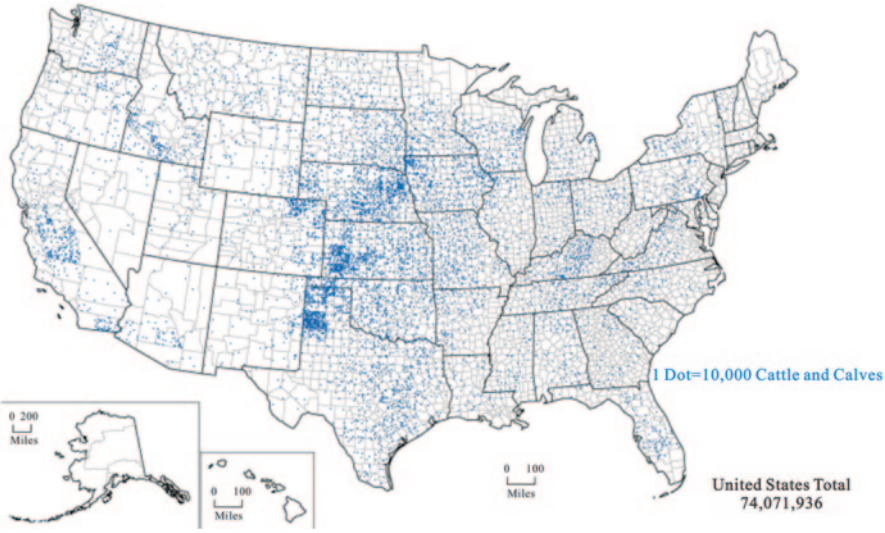

Fig. 10.20 Where cattle and calves were sold at auction. 1 *dot* is equal to 10,000 sold. The High Plains, (Texas panhandle, western Kansas and central Nebraska and north eastern Colorado) are the most important sources for cattle. (Map courtesy of U.S. Department of Agriculture National Agricultural Statistics Service 2007. http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/Fact_Sheets/Geographic/ag_atlas.pdf)

top dairy cattle states with Texas being the third leading dairy cattle State. Texas is the leading beef cattle raising State, however. Inside of a large State like Texas, areas with many dairy cattle are different and separated in most cases from those areas where many beef cattle are raised. Dairy cattle are concentrated in areas with better grazing in the central portion of the State of Texas near Waco. Beef cattle production is more widespread in Texas, but is concentrated in the portion of the "panhandle" of Texas that is within the High Plains. Frequently beef cattle are born and spend their early months with their mother cows and at a sufficient age (and weight) the calves are sold at local auctions. The cow-calf operations are often small family farms with a few hundred hectares of land, the feed lots are often vast mechanized facilities that could be in another State. Many of the cow-calf operators only supplement their income by farming and depend on other jobs for their livelihood. The feedlots are usually closer to sources of grain, while the cow-calf ranches are in areas with good pastures.

Beef is processed in yet other even more centralized facilities often in states like Oklahoma and Nebraska. Most of the beef is consumed inside the U.S. However, in 2011 501 million pounds (238 million kg) of beef was exported from the U.S. The value of the beef exported in 2011 was slightly over $ 1 billion. In 2011 the top 4 countries importing U.S. beef were Japan, Mexico, South Korea and Canada. In 2011, no U.S. beef was exported to China. This is because in 2003 China instituted a ban on imports due to bovine spongiform encepalopathy (mad cow disease) in the U.S. herd. In 2002 the value of U.S. beef exports to China was $ 150 million, since

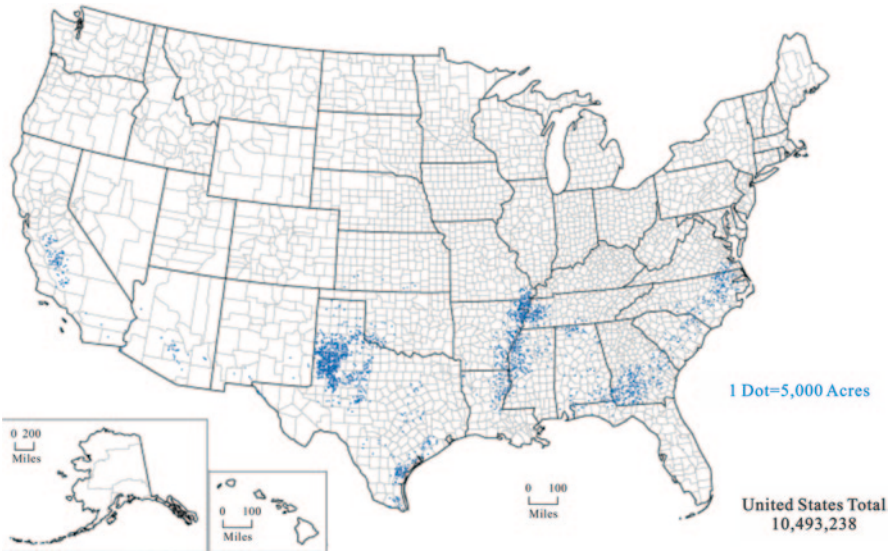

Fig. 10.21 Cotton Production in 2007. Note that the High Plains, particularly the panhandle of Texas is very important in cotton production. In 2010 Texas had the highest production of cotton in the U.S. (Map courtesy of U.S. Department of Agriculture, National Agricultural Statistics Service 2007. http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/Fact_Sheets/Geographic/ag_atlas.pdf)

then the trade in beef in either direction is non-existent. Although only two cattle with BSE have been found in the U.S., as of 2012, the ban remains in effect.

Other Crops

While wheat and cattle are the mainstays of agriculture in the High Plains, some other crops and animal products (poultry in particular) are also raised there. The High Plains are not a very diverse area. The vast extent of lands, the harsh climate and the large scale logistically driven farming practices do not lend themselves to multiple specialty crops. Prices for commodities are now an important part of the decision to plant a particular crop or rear a particular animal. Corn prices in the U.S. are driven by a subsidy on ethanol for fuel that has prompted a rise in corn production and conversion of what was usually wheat land in the High Plains into corn production. Recent high prices for cotton have spurred more cotton production in the High Plains (Fig. 10.21). Texas is a center of cotton production, growing over 4 million bales (about 1,000 metric t) worth over $ 1 billion. The cotton is raised on 6 million acres, mostly in the panhandle. Texas is first among U.S. states in cotton production and the U.S (See Chap. 4) is the world's second largest cotton producer. China is the largest producer of cotton raising 25 million bales compared to 17 million bales raised in the U.S. in 2010 (Nationmaster 2010).

There are crops in the High Plains besides wheat and cattle and to a lesser extent cotton and corn that are important. Swine are increasingly being produced, not least because other more densely populated areas are complaining about the odor of large scale swine CAFO's. The large swine farms of in the Texas panhandle (some of which are Japanese owned) and in the Guymon, Oklahoma area are good examples. There are some other types of livestock raised in the region including chickens and turkeys, particularly in the south eastern area that does not get as cold. There is also one uniquely American animal: the bison (American buffalo) which has made a comeback. Today there are over 500,000 bison in commercial ranches, mostly in the High Plains. Bison are naturally well suited to the climate of the High Plains. Their meat has less fat and more protein than beef and their pelts and leather fetch premium prices. One major difficulty in bison production is that ordinary fences cannot contain the animals, so high wire mesh or electrified fences with large wooden or steel posts set in concrete are often required to contain bison herds. The bulls, which can weigh 1,000 kg, are particularly difficult to manage. Ted Turner (founder of the CNN News Network) is the owner of the most private land in the U.S. In 2010 he owned over 2 million acres of ranch lands, much in the High Plains and he has over 50,000 bison on his ranches in New Mexico, Oklahoma, Kansas, Nebraska, South Dakota and Montana. The scale of his operations allows him to profit from diversification, including wind and solar energy production and tourism and recreational hunting on his lands. (Turner 2010).

Sorghum, barley, oats, and sugar beets are all produced in the High Plains. Other root crops like potatoes and onions are grown; there is limited production of fruit. One of the most important recent economic diversifications in the High Plains has been another sort of farm: the wind farm. One factor that has driven the population down historically has been the high and seemingly unceasing winds in the High Plains. A source of misery during the dust bowl and during summer dust storms and winter blizzards is now a source of prosperity. Wind turbines do not significantly interfere with extensive wheat or cattle operations. Many of the ranches with wind turbines now in operation also have oil or gas wells that are now often depleted, but the new energy bonanza will not run dry in the foreseeable future. China is presently one of the largest manufactures of wind turbines, with most of the huge turbines arriving through the Ports of Houston and Corpus Christi and moving in several pieces on trucks by Interstate highways up to the panhandle of Texas and other areas that are transverse by power lines taking the energy generated in the High Plains to cities as far away as Dallas, Chicago and Denver. Given the reliance of the High Plains on rapidly depleted groundwater, the existence of a low cost perpetual energy source will play a role is sustaining irrigated agriculture and in fact makes the economy of the region less reliant on farming of any sort (High Plains Wind 2010). Whether wind energy will help to reverse the decline in population remains to be seen.

10.4 Conclusions

The world has several great “Bread Baskets” and “Rice Bowls”. These are areas where due to rich soils, adequate water resources and available arable lands and infrastructure, cereal production can far exceed local demand. The surplus then is available for export or for livestock production. These areas may meet national demand as in India and the Nile Valley or they may produce such a surplus that domestic demand is greatly exceeded as in the Ukraine and Kazakh steppe, the Argentine pampas, the rice paddies of Thailand, the grain belt of Australia and the Corn belt of the Midwestern U.S. and the High Plains of America and the Canadian prairies. China also has a number of food production centers that exceed regional demand and provide for some international exports. Those areas producing the greatest regional surpluses are the Northeast China Plain, the North China Plain and the Middle-Lower Yangtze Plain.

In these three key regions in China natural and socio-economic factors have produced differences in cropping systems and the types of crops raised in the three main agricultural production regions (bases). The Northeast China Plain mainly grows wheat, corn and soybeans. The North China Plain mainly grows wheat, corn, and cotton, and the Middle Lower Yangtze Plain mainly grows rice, rape seed, mulberry (for silk production) and tea; fishing is also highly developed in this region. In recent years, the center of gravity of agriculture in China has shifted from the Middle-Lower Yangtze Plain to the North China Plain and the Northeast Plain.

The production of the three main agriculture bases constitute about three-quarters of the total food production of the whole country. This in turn guarantees China’s food security, and also, to a great extent, eases the world food security situation. China’s major grain producing areas are also its main consumer areas—as the eastern plains are densely populated. With the development of an industrial oriented economy, the agricultural land area is shrinking. Therefore, the most important agricultural development imperative must be to sustain and enhance grain production lands by use of modern production technology and improve the intensity and efficiency of agricultural production in these vital regions.

The Corn Belt and High Plains are two of the most important agricultural regions in the U.S. The economy of each is based on production of cereals, primarily corn in the Corn Belt and wheat in the High Plains. These crops in turn support many other industries, in particular livestock production and ethanol manufacture. Swine production is centered on the Corn Belt and beef cattle ranching and feedlots in the High Plains. Climate and soils related factors account for the productive differences between these regions. Historical and physical factors account for their settlement and ownership patterns, with the Corn Belt supporting more and smaller, mostly family owned farms and the High Plains supporting larger often corporate owned ranches, feed lots and irrigated farms. Geographical factors such as transportation networks, availability of large tracts of land and central location all play a role in the economic significance and high production efficiency of these regions. The global importance of these areas has grown recently for a variety of reasons including the

development of large scale concentrated animal feeding operations, many geared toward export and the use of corn for production of ethanol. In any case, with a growing world population, these two regions will play a vital and growing role in the world economy.

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