

ENCYCLOPEDIA OF GLOBAL INDUSTRIES



SIXTH EDITION

Encyclopedia of Global Industries

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**Encyclopedia of Global Industries,
Sixth Edition**

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Introduction

Now in its sixth edition, the *Encyclopedia of Global Industries (EGI)* continues to serve as a key source for inquiries into industry sectors on a global scale. No other publication or electronic database offers the same level of international breadth and industry depth as the *Encyclopedia of Global Industries*, and few rival it in currency and accessibility.

This volume contains 125 articles in 23 chapters spanning industry topics from agriculture and mining to semiconductors and engineering services. Each entry lays out an overview of current trends, background on past developments, and profiles of leading companies and countries. Significant data and trends are illustrated in tables and charts, and a list of references for further research is supplied for every topic.

For the convenience of experienced researchers, the encyclopedia identifies industry topics with corresponding categories from the North American Industry Classification System (NAICS), originally published in 1997 and most recently updated in 2017. Industry profiles reflect and address the most current updates to this system. The NAICS system is widely used by business and economic researchers to provide a common statistical and conceptual language for the study of industry. To aid users in understanding the focus of each article, an industry definition paragraph appears at the beginning.

HOW TOPICS ARE CHOSEN

The present roster of 125 topics has evolved from two main sources, as well as through the development of past editions. Many were suggested by panels of business experts from academia and business libraries. The remainder were selected by the editors based on such criteria as the annual revenue size of the global industry, the popularity of the topic among researchers, and how well the topic represents the diversity of global economic activity.

CONTENT AND ARRANGEMENT

Despite the varied subject matter treated in this volume, industry narratives are presented following a standard set of topical themes. Every essay includes some or all of the following categories of discussion:

Industry Snapshot. Identifies issues covered later in the article and highlights key facts to understanding the industry.

Organization and Structure. Covers logistical and structural aspects of the industry, including definitions of leading products and services, regulatory and legal matters, and the international make-up of the industry.

Background and Development. Introduces treatment of the industry's origins and past trends, including important innovations and the individuals who made them.

Current Conditions. Provides important recent trends and statistics, including those with implications for the future.

Research and Technology. Discusses recent advances in technology that may signal emerging trends for the industry in the future.

Workforce. Addresses demographics, compensation, and issues of the labor force.

Industry Leaders. Profiles major companies, including recent annual sales, historical notes, and specialties within the industry.

Major Countries in the Industry. Provides country- or region-specific summaries of the industry.

Bibliography. Lists sources for additional research, including specific books or articles that may be referenced in the entry as well as works offering general information on the industry.

STATISTICAL CHARTS AND TABLES

The *Encyclopedia of Global Industries* includes tables, graphs, and charts to highlight key statistics and themes. When all data in the table or graphic has come from a single proprietary source, a reference is given at the bottom. Sources of data in the public domain or compiled or adjusted by the editors are generally not specified; however, readers may refer to the essay's Bibliography section for leads on where comparable data might be obtained.

ACCESS TOOLS

Indexes. The *Encyclopedia of Global Industries* includes three indexes:

Industry Index. Contains a listing of the 2017 North American Industry Classification System (NAICS) references that correspond to the encyclopedia's industry topics.

Geographic Index. Provides an alphabetic listing of countries and regions mentioned in the book and subdivided by industry. The index includes cross-references for variant names.

General Index. Provides an alphabetic listing of industries, companies, organizations, legislation, concepts, and prominent individuals referenced throughout the book. The complete list of the encyclopedia's industry topics may be found in this index along with cross-references to common keywords and acronyms.

COMMENTS AND SUGGESTIONS

Gale welcomes your comments and ideas pertaining to the *Encyclopedia of Global Industries*. Readers needing more information about this or other Gale business products are encouraged to contact the editor:

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AGRICULTURE

NAICS 111

AGRICULTURAL PRODUCTION—CROPS

Crop production provides the bulk of human nourishment. Primary categories in the industry include grains, general field crops, vegetables, and fruits. For the cultivation of plants underwater see **Aquaculture**.

INDUSTRY SNAPSHOT

Statistics for global crop production begin in summer of a given year and end the following summer. Corn, wheat, and rice are the most abundant crops. Combined production of these grains was relatively flat at around 2 billion metric tons (mt) in global annual production over the three years from 2011 to 2013, with a slight increase to 2.1 billion mt forecast for the 2014–2015 season, according to the U.S. Department of Agriculture (USDA) Foreign Agricultural Service (FAS). Maize (corn) accounted for nearly half of global grain production in the 2010s, which was primarily used for livestock feed. The United States was the leading producer of corn, with a 36 percent share, followed by China, Brazil, the European Union, and Ukraine. The 28 member countries of the European Union produced the most wheat; while China, India, and the United States were the single countries with the most wheat output in 2014. China and India were the dominant producers of rice, which was used exclusively for human consumption.

Among fruit crops, bananas, apples, and oranges were the most abundant. Brazil was the leading producer of oranges. China dominated deciduous fruit production, which included apples, pears, and grapes. Mangoes and pineapples were the most significant tropical fruits.

Potatoes were the leading vegetable crop, followed by tomatoes, onions, and carrots. Significant field crops were sugar (sugarcane and sugar beets), cotton, coffee, and tobacco. Brazil dominated sugar and coffee, while China dominated cotton and tobacco. The combined oilseed category, which included soybeans, sunflower seeds, cotton seeds, flaxseeds, and canola seeds as well as sesame seeds and poppy seeds, was approximately equivalent to rice production. Soybeans accounted for nearly half of oilseed production. Brazil briefly took the output lead from the United States in 2012, but dropped back to second place in 2013 and 2014. China and India were the leading producers of peanuts.

ORGANIZATION AND STRUCTURE

The crop production industry comprises everything from small subsistence farmers to immense vertically integrated food conglomerates. Subsistence farmers generally operate small plots, while large organizations typically operate fields up to thousands of acres. Fields may be either owned or rented by a family or farming establishment. The future of farming in industrialized nations was reflected in the persistent decrease in the number of farms.

The organizational levels within the farming community are geared toward moving raw ingredients from the farm to the end consumer. This chain can be short and direct when a farmer grows produce and his customer comes to the farm to make a purchase or the farmer takes his produce to a local market. More often, however, many marketing and processing levels are involved. A frequently employed intermediate step can be farm sales to granaries, processors, or wholesalers.

Farm transactions can be handled in several different ways. For example, the farmer may grow a crop, harvest it, and receive payment when it is delivered to market, or

the farmer may make arrangements to sell his entire crop (or a predetermined percentage of it) at a specified price before he grows it.

Many governments, especially those of the world's major crop producers, tend to carefully regulate the agricultural industry, which is a major economic force. Direct subsidies, low-interest loans, and guaranteed prices were offered to farmers to ensure strong agricultural performance.

BACKGROUND AND DEVELOPMENT

Some historians have equated the beginning of agriculture with the origins of civilization. Although they do not always agree on where crop cultivation originated, some possible places are China, India, the Middle East, South America, Sudan, and Southeast Asia. Some believe that agricultural techniques began in one place and spread throughout the world, while others believe that agriculture was developed independently in various locations.

Grains. One of the most important crop families in the global economy is grain, with main categories of wheat, coarse grain, and rice. Coarse grains are primarily corn used as livestock feed, but the category includes millet, sorghum, barley, oats, rye, and mixed grains. Grain cultivation began in prehistoric times when early farmers, perhaps relying on their experience with nature, selected seeds from useful plants and attempted to control where and how they grew.

Some accounts claim that the first grain to be domesticated was wheat, which was important because of its unique gluten content. Gluten is the protein that gives wheat-based dough its ability to rise. Rising occurs when carbon dioxide produced during yeast fermentation becomes trapped in the dough. Gluten also gives dough elasticity and gives bread a chewy texture. Without wheat, there would be no leavened bread.

Another grain with a long history of cultivation is rice. Rice cultivation probably originated in mainland Asia before it was introduced to other areas. Cultivation of rice in the Philippines is thought to date back to between 4000 BCE and 3000 BCE. When the indigenous people adopted rice, it probably supplemented domestic root crops like taro and sago. As it became established as a crop, its value increased and it was interwoven in the nation's culture.

In drought-susceptible regions of Africa, native crop production originally focused on millet and sorghum. When irrigation was possible, yields improved, which enabled farmers in drought-plagued areas to be self-sufficient. One type of millet, commonly referred to as "pearl millet," was able to grow quickly in a short, rainy season, while sorghum was cultivated in tropical regions.

In the Andes mountains in South America, the Incas cultivated, stored, and distributed grain harvests. Early grains included quinoa, kiwicha, and kaniwa. Quinoa, a versatile grain able to grow in rugged terrain and withstand extreme weather fluctuations, was one of the most popular early grains. When the Spanish arrived and conquered the local tribes, they sent indigenous farmers to work in the gold mines, and the cultivation of native plants diminished. Subsequently, indigenous agriculture continued to be eroded by the large-scale wheat imports by Peruvian government officials.

Maize was important to early civilizations as a grain crop native to the Americas. The first maize was a tropical grass that may have originated in Mexico. Some historians place the origins of its domestication and cultivation in South America around 5000 BCE. Maize cultivation in North America began sometime in the first two centuries CE in what is now the Southwest United States when it was first cultivated by the indigenous population that presumably had prior knowledge of agricultural techniques. By 800 CE, maize was also being cultivated in the eastern part of North America.

Maize was unknown in Europe before Columbus allegedly discovered it in Cuba and carried seeds back to his home. By the mid-sixteenth century, maize was popular in southern Europe. In northern Europe, maize was initially used for livestock rather than for human consumption. The grain was exported from Europe to the Philippines and Asia and was taken to Africa by Portuguese traders where it thrived because it was drought-resistant. Overreliance on maize, however, led to vitamin deficiencies for some African populations.

According to the Economic Research Service of the USDA (ERS), corn moved ahead of wheat as the world's leading cash grain around the start of the twenty-first century, increasing from 580.6 million metric tons (mmt) in 1997 to 700.6 mmt in 2005, an increase of more than 27 percent. The United States produced 300 mmt in 2005 and increased to 351 mmt of global corn production of 988 mmt in 2013. Corn exports rose from 90.7 mmt in 2005 to 100.5 mmt in 2013, of which the United States exported 18.3 mmt.

Global wheat production continued to fluctuate, reaching 658.7 mmt in 2013. The leading wheat producers were the European Union, China, India, the United States, and Russia. Leading wheat exporters in 2013 included the United States (27.7 mmt), the European Union (22.6 mmt), Australia (21.3 mmt), and Canada (18.5 mmt). Egypt was the major importer at 8.3 mmt.

World rice production increased steadily after the early 1990s, reaching 389.2 mmt in 2004. Rice continued to be ranked third behind corn and wheat with output at 471.9 mmt in 2013. China was the leading

producer with 143 mmt, followed by India (105.2 mmt), Indonesia (36.55 mmt), Bangladesh (33.8 mmt), and Vietnam (27 mmt). Major rice exporters in 2013 were India with 10.48 of the 39.5 mmt in global exports, followed by Thailand and Vietnam.

Fruits and Vegetables.

Citrus Fruits. Citrus fruits, such as oranges, grapefruits, tangerines, lemons, and limes, originated in Southeast Asia and in the East Indies. They were first introduced to Europeans during the twelfth century. Prior to the development of modern processing technology, citrus could only be sold in limited areas. Primary regions involved in commercial citrus production were North and South America, the Mediterranean, Australia, and South Africa.

In the 1940s, the development of citrus concentrate brought changes to the citrus industry. Other innovations were the ability to extend product storage life and improvements in transportation. Instead of being limited to a local market, growers were able to reach all corners of the world and overcome problems associated with their products' seasonality. Large-scale, modern commercial citrus producers generally grew their fruit in orchards on "composite" trees. Composite trees are trees with a rootstock that differed from their "scion," the upper portion of the plant that was grafted onto the rootstock. The rootstock was selected based on its ability to thrive in specific conditions. Important features included a natural resistance to diseases and pests and the ability to grow well in local soils. The scion was selected for the quality of its fruit.

Rising incomes and improvements in packaging transportation that lowered costs and improved quality of citrus fruits resulted in rising consumption. Citrus production rose from 60 mmt in 1985 to above 100 mmt by 1995 and during the early years of the twenty-first century. Brazil and the United States remained the dominant producers throughout that period. One-third of citrus production was processed into juice and other products. At output of 62.7 mmt in 2004, oranges accounted for more than half of citrus production and were the largest fruit crop behind bananas.

Brazil, the leading orange grower, produced 18.2 mmt in 2004, an increase of almost 23 percent from 2002. In 2011 this figure reached 20.6 mmt, but it fell by 2014 to 16.85 mmt. Orange yields increased in the United States to an estimated 12.3 mmt in 2004, almost 17 percent more than 2002, with a 79 percent share of the country's total citrus crop. However, tree diseases and hurricanes caused significant damage to citrus groves in Florida. Production was only 8.2 mmt in 2011 and continued dropping, to 6.15 mmt in 2014.

Tropical Fruits. Nearly half of global banana production consists of Cavendish bananas, a type of sweet banana, with the remaining share composed of plantains and other dessert and cooking bananas. After a soil fungus began to wipe out the Gros Michel cultivar in the mid-twentieth century, it was replaced by the fungus-resistant Cavendish. India was the leader in Cavendish banana output with more than 20 percent of the market, but Latin America was the primary producing region, with Ecuador as the major Latin American producer. Plantains were mainly produced in Africa and Latin America, while other types of cooking bananas were grown in Africa and Asia.

World production of sweet bananas rose from 42.5 mmt in 1985 to 63.4 mmt in 1998, at which time production of all varieties totaled 92 mmt on 9 million hectares. Exports of bananas from Latin America doubled to 10 mmt during that period. Ecuador was the main exporter, which began producing bananas when cacao lands were converted to banana plantations in the 1930s. The United States and Europe were the primary import markets for bananas.

Bananas remained the largest fruit crop in the world, exceeding 100 mmt for the first time in 2009 and rising to 107.1 mmt by 2011. Exports rose from 11.9 mmt in 2000 to nearly 16.5 mmt in 2012, according to the Food and Agriculture Organization of the United Nations (FAO). Production grew by 500,000 tons in 2012 in Central America and the Caribbean at the same time flooding cost Ecuador 416,000 tons. Still, Ecuador contributed almost one-third of the banana trade at 3.9 mmt, followed by 1.88 mmt from Costa Rica, 1.68 mmt from Colombia, 1.59 mmt from the Philippines, and 8.1 mmt from Guatemala. The United States and Europe were the destination of half of the world's banana exports in the mid-2010s, with each market accounting for 27 percent of global trade.

Half of tropical fruit production in 2004 was mangoes, a native fruit of India and southeast Asia. Mangoes were produced in 85 countries but concentrated in 10 countries. According to the FAO, world mango production increased only 1.7 percent from 1995 to 2004, while the area planted increased from nearly 2.9 million hectares to 3.7 million hectares. Mango production in 2004 was 26.4 mmt, of which India produced 10.8 mmt and China produced 3.5 mmt. World production rose to about 30 mmt by 2010 with India's output increasing above 12 mmt. By 2014 India was producing 16.3 mmt annually, or more than 40 percent of global production. China was second with an 11 percent market share, followed by Thailand, Pakistan, and Mexico. The FAO estimated mangoes would account for 35 percent of the global tropical fruit production in 2014 at 28.2 mmt.

An estimated 90 varieties of pineapple are grown; however, only eight varieties are produced commercially. Most pineapple is grown in Brazil, the Philippines, Costa Rica, and China. Approximately 30 percent of all pineapples were exported in 2008, primarily by Costa Rica to the United States and European Union. Costa Rica accounted for 29 percent of global production in 2014, while the United States was the largest importer with 38 percent of global trade. The FAO estimated global pineapple production in 2014 would total 18.3 mmt, representing 23 percent of the global tropical fruit harvest.

Deciduous Fruits. Global apple production increased during the 1990s and was the third-largest fruit crop with 59 mmt in 2004. China was the dominant producer with 20.5 mmt; the European Union produced 12.2 mmt, and the United States produced 4.2 mmt. Global apple production reached 71.6 mmt in the mid-2010s, with China producing 39.7 mmt; the EU 12 mmt; and the United States, 4.8 mmt. As well as leading production, China and the European Union were the major exporters, although a 5 percent drop in global trade was forecast for 2014–2015 due to a Russian ban on fruits and other agricultural products from selected countries. China and the European Union also dominated pear production, which rose from 18 mmt in 2004 to 23.2 mmt in 2014. China produced an estimated 9 mmt of the 20.6 mmt of grapes produced in 2014. Chile was a major grape exporter of 825,000 metric tons of total exports of 2.8 mmt. The United States, Europe, and Russia were the primary grape importers. However, a slightly smaller Russian total of 385 tons was forecast due to the government import ban.

Vegetables. Potatoes also originated in the Americas, perhaps in Mexico, and spread south. Wild potatoes grew at least 13,000 years ago and have been cultivated for 9,000 to 10,000 years. During the sixteenth century, Spanish explorers took potatoes back to Europe. Seventeenth-century British settlers brought them back to North America via Bermuda. Potatoes were introduced to Japan and China during the seventeenth century and to New Zealand during the eighteenth century.

Potatoes were popular among the poor in eighteenth- and nineteenth-century Europe because they could be grown easily in small family gardens and had high nutritional value. A farmer could feed about four times as many people per acre with potatoes as he could with wheat or rye. Sailors took potatoes with them on long voyages because they are high in vitamin C, which prevented scurvy. However, people depended too much on potatoes, causing potato famines like those in Ireland in the nineteenth century, when the potato crop was contaminated repeatedly by blight.

Despite blight and famines, potatoes became a favored crop in many places worldwide. Several varieties were

developed to thrive in different growing conditions. In addition to being a nutritious and popular food, potatoes were used in several industrial applications. For example, during the nineteenth century, potato starch derivatives were used to make syrup and sizing agents, and manufacturers used potatoes in the production of paper, adhesives, and textiles. During World War II, the German military used potatoes to make an alcohol-based aircraft fuel, light streetlights, and power ground vehicles. Potatoes also have provided ingredients for cosmetics, pharmaceuticals, and even disposable diapers.

World production of potatoes rose from 316.4 mmt in 2002 to 364.8 mmt in 2012, according to the National Potato Council's *2014 Potato Statistical Yearbook*. China remained the leader, increasing from 70.2 mmt to 85.9 mmt during the period. India was the second-largest producer, jumping from 24.5 mmt to 45 mmt. Russia, Ukraine, and the United States rounded out the top five producers. Since development of frozen French fry techniques in the 1970s, processed potatoes surpassed fresh use in the United States.

Indigenous to South America, tomatoes were introduced to Europe in the sixteenth century. Because of an early misclassification, the English believed that tomatoes were poisonous, so they did not begin to cultivate them until the early nineteenth century. However, some southern European countries began to cultivate them immediately, integrating them into their diet and treating them as a delicacy. Long before Europeans discovered the tomato, however, the Aztecs had mixed them with chili peppers, making salsa. By the twentieth century, tomatoes had become one of the world's most popular vegetables in fresh and processed forms. World tomato production was 115.9 mmt in 2004, rising to 153 mmt by 2009 and 163.9 mmt in 2013. China produced 50.6 mmt, followed by India and the United States with 18.2 mmt and 12.51 mmt, respectively.

China was also the major producer of carrots and onions. Total onion output was 53.5 mmt in 2004, and exceeded 80 mmt in the early 2010s. China, India, the United States, Egypt, Iran, Turkey, and Pakistan led production. The worldwide carrot harvest in 2004 was 23.6 mmt, growing to 37.2 mmt by 2013. The United States was the fourth-largest producer of carrots, just behind Uzbekistan and Russia. All three produced less than 2 mmt annually. They distantly followed China, which produced 45 percent of the world's carrots at 16.9 mmt. Carrots were thought to be native to Asia; cultivation of them in the United States began with the colonists.

Field Crops.

Sugar. Sugarcane and sugar beets are used to produce sugar. Historians believe that sugarcane was first

cultivated in prehistoric Asia and exported to Europe as early as the fifth century CE. Sugarcane was grown in Egypt's Nile River Valley in the eighth century and was introduced to Central and South America during the sixteenth century. Sugarcane continues to be cultivated in tropical and semitropical regions. Sugar beets were first grown in southern Europe about 1800. There are many varieties of sugar beets, but *Beta vulgaris* is the most important commercially. Sugar beets are grown in the temperate climates of the European Union, the United States, and Russia.

Sugarcane comprises the bulk of the sugar industry, led by Brazil, India, and China. World production of sugar was 167.1 mmt in 2006, at which time Brazil and India each contributed 20 percent of output at 32.1 mmt and 31.8 mmt, respectively. Approximately half of Brazil's sugar was used in ethanol production. After two consecutive record years, India went through three years of lower production, which had fallen to 20.6 mmt by 2009. Global production of sugar beets was dominated by the European Union with 17.8 mmt. The United States produced sugar from both sugarcane (in Hawaii and along the Gulf of Mexico coast) and sugar beets with production of 7.7 mmt in 2006.

Over the next several years, worldwide sugar production rose to 175.5 mmt in 2014. Brazil remained the top producer with 36.8 mmt, followed by India (37.9 mmt), the European Union (16.3 mmt), and China (13.7 mmt), according to *Sugar: World Markets and Trade*, a report published by the USDA FAS in November 2014. Thailand's sugar output surpassed the United States in 2010 and maintained its lead through 2014, rising from 6.9 mmt in 2006 to 11 mmt while the United States dropped to 7.7 mmt. Brazil exported the majority of its sugar, with 25.2 mmt in 2014, representing nearly half of all world sugar trade (55.2 mmt).

CURRENT CONDITIONS

Providing enough food for the world's 7 billion people remained a serious challenge in the 2010s. One suggested solution to solve global hunger was to stop the spoilage of tons of fruit and other produce that is wasted annually in countries in which large numbers of people with nutritional deficiencies live. For example, in Pakistan, agricultural analysts estimated that up to 3 million tons of fruit and produce were wasted annually as a result of substandard harvesting and packing methods. Food waste was a problem in developed countries as well. According to a 2012 study by Barilla Center for Food and Nutrition, worldwide, one-third of all food production intended for human consumption was wasted every year. In Europe alone, that was equal to 396 pounds per person. According to Guido Barilla of the Barilla Center in

Entertainment Close-up, "Food losses and waste cast a worrisome shadow over the model of growth that has governed the global economy for the past fifty years—a model that is totally unsustainable."

Many other concerns plagued the future of food production. For example, the FAO reported that crop growers had to find a way to grow more crops with less water because by 2030 the world's water supply would be unable to meet projected crop irrigation demands. Irrigation use would have to increase more than 80 percent by 2030 to satisfy projected global food demand.

Grains. Corn and wheat reached record global production levels in 2013, a trend that continued the next two years. Corn production was estimated at 991.2 mmt in April 2015 for the 2014–2015 season, as compared to 988.7 mmt in 2013–2014 and 867.9 mmt in 2012–2013. The United States, which dominates corn production, had a crop of 361 mmt in 2014, an increase from 351.2 mmt in 2013. China produced 215.5 mmt, the European Union 74.1 mmt, and India 22.5 mmt of corn in 2014. Wheat production increased from 695.9 mmt in 2011 to 724.7 mmt in 2014. The European Union was the top producer with 155.6 mmt, followed by China with 126 mmt. India, Russia, and the United States rounded out the top five. Global rice output increased to 476.8 mmt in 2013, then fell slightly to 474.8 mmt in 2014. Although global per capita consumption of rice was expected to continue falling, overall rice demand was anticipated to expand, keeping pace with population growth. After reaching historic highs in 2011–2012, prices fell throughout 2013 and remained low into early 2015.

Significant Fruits and Vegetables. Apples were the most significant deciduous fruit with estimated global production of 70.8 mmt in 2014. China accounted for more than half of production at 39.7 mmt, followed by the European Union with 13.3 mmt. Pear production was estimated at 24.4 mmt in 2014, of which China produced 18.5 mmt, followed by the European Union with 2.4 mmt. The world grape harvest increased slightly in 2014 to 20.6 mmt.

Oranges were the most abundant citrus fruit with production of 51 mmt in 2014. Brazil produced 16.8 mmt in 2014, of which 11.3 mmt were processed rather than consumed fresh. China produced 7.6 mmt, followed by the European Union with 7.6 mmt and the United States at almost 6.2 mmt. China consumed almost 20 percent of the world's fresh oranges.

According to the USDA, U.S. farmers grew 446.7 million hundredweight (cwt) of potatoes in 2014, down from 457 cwt in 2012, which was the largest

Leaders in Global Fruit Production, 2014

in million metric tons (mmt)

Apples	
Total	70.8 mmt
China	39.7 mmt
EU	13.3 mmt
Pears	
Total	24.4 mmt
China	18.5 mmt
EU	2.4 mmt
Oranges	
Total	51 mmt
Brazil	16.8 mmt
China	7.6 mmt
EU	7.6 mmt
US	6.2 mmt

SOURCE: Food and Agricultural Organization of the United Nations

crop since the turn of the century. Both acres planted and yields dropped slightly from 2013 to 2014, when acres totaled 1.06 million and yield averaged 426 ctw. Top exporters were the European Union at 550,000 tons; Canada, 475,000 tons; and the United States, 450,000 tons, according to USDA statistics for the 2013–2014 season.

World sugar production declined from 176.0 mmt in 2012 to 174.8 mmt in 2013 due to drought conditions in India and the United States, then recovered to 175.6 mmt in 2014. Brazil produced 36.8 mmt, of which approximately half was used to manufacture ethanol. With exports of 25.25 mmt, Brazil accounted for 45 percent of global trade. India produced 27.9 mmt of sugar, followed by the European Union at 16.3 mmt, China at 13.7 mmt, and Thailand at 11 mmt.

RESEARCH AND TECHNOLOGY

In addition to working to improve crop yields, researchers were developing ways to farm without causing damage to the environment, such as no-till crop methods that protect topsoil from erosion up to 98 percent. However, critics claimed that no-till methods caused other environmental damage because they required more chemicals, such as herbicides and pesticides. Proponents of no-till farming pointed out that improved pesticides killed targeted species by disrupting reproduction cycles without causing harm to other species.

MAJOR COUNTRIES IN THE INDUSTRY

China. China remained a leading producer in many categories of grain, fruits, vegetables, and field crops. In spite of China's enormous production, it often failed to meet its domestic demand, necessitating heavy imports.

China is the leading producer of rice and, excluding the European Union, of wheat. Despite rice production plummeting from 195 mmt in 1997 to 144.5 mmt in 2014, China still remained ahead of India. Wheat production climbed steadily to 126 mmt in 2014. China's corn production was far greater than rice or wheat at 215.5 mmt, but it trailed behind the United States, which dominated at 361 mmt in 2014.

Known for its apple blossoms, China was the dominant producer of deciduous fruits, including apples, pears, and grapes. It was also the second-largest producer of oranges, behind Brazil. China was the leading producer of potatoes, tomatoes, and onions.

The United States. The United States was the world leader in corn and a major supplier of wheat. Other major grain crops are rice, sorghum, barley, and oats. A historic drought in the summer of 2012 affected about 80 percent of U.S. agricultural land, and on August 1 the USDA declared more than half of all U.S. counties as disaster areas. Corn production fell 13 percent and soybean production fell 3 percent, placing the United States behind Brazil in soybean production for the first time. The geographic scope of the drought shrank in 2014 and early 2015, although the USDA forecast continued water shortages in California and a more intense drought in the Southwest.

The United States remained the world leader in corn production (361 mmt) and corn exports (44.5 mmt) in 2014, primarily for livestock feed. Corn was also used in fuel ethanol, starch, sweeteners, corn oil, and beverage and industrial alcohol. Corn acreage increased from a low of 60 million acres in 1983, when the government was regulating crop decisions, to more than 90 million acres 40 years later.

The United States was the fifth-largest producer of wheat in 2014 with 55.1 mmt, of which 32.5 mmt was exported, according to the USDA FAS. U.S. wheat production had been in decline since the 1980s, and the USDA forecasted that trend to continue with acreage shrinking by another 50 million acres by 2022. While production would increase with domestic consumption from population growth, this would be offset by U.S. exports falling from 19 percent to 16 percent of the global wheat trade.

U.S. orange production was decreasing in the mid-2010s. Production totaled just above 8 mmt in 2010 and 2011, but dropped to 7.56 mmt in 2012 and 6.15 mmt in 2014. It was forecast at 6.1 mmt in 2015.

The European Union. The European Union was a long-standing leader in wheat production. The European Union produced 155.6 mmt of wheat in 2014. The European Union was the fourth-largest producer of corn in 2013 with output of 64.7 mmt.

The European Union was also a leading producer of deciduous fruit in 2013. Although far behind China as the leader, the European Union was the second-largest producer of apples with 13.33 mmt and pears with 2.4 mmt in 2014. It was the third-largest producer of grapes behind China and Turkey at 1.6 mmt. The European Union was also a significant producer of oranges, trailing Brazil and China but overtaking the United States for third place in 2014 with 6.7 mmt.

India. India was the largest producer of fruits and vegetables after China. As of 2013, India was the leader in output of bananas (24.89 mmt) and mangoes (16.33 mmt), the second-largest producer of potatoes and onions behind China, and the second-largest producer of tomatoes behind China. India was also a significant producer of grains, placing second in rice behind China, third in wheat behind the European Union and China, and a distant ninth in corn. India placed behind Brazil as the second-largest producer of sugar.

Brazil. Brazil is the native country of pineapple and was one of the top producers in the mid-2010s. Brazil was the top producer of oranges since overtaking the United States in the 1980s. Brazil produced 20.6 mmt of oranges in 2011, which fell to 16.8 mmt in 2014, due to less acreage and poorer yields after good crops in 2010 and 2011. About one-third of Brazil's oranges were consumed as fresh fruit, and two-thirds were processed into juice.

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AGRICULTURAL PRODUCTION—LIVESTOCK

The agricultural production—livestock industry includes commercial farms, ranches, dairies, hatcheries, and other facilities that raise or tend animals to supply the world's food markets. Specific categories include dairy and beef cattle, goats, hogs, poultry, and sheep. See also **Agricultural Production—Crops**.

INDUSTRY SNAPSHOT

While overall food per capita demand is relatively fixed, the general economy determines the types and quantities of foods that are purchased. The livestock industry, which often mirrors the general economy, increases during economic expansion and decreases or stagnates in recessions. The first decade of the twenty-first century showed a dramatic shift toward consumption of meat and dairy products, particularly in developing countries in Asia. With population growth of 2 billion people expected by 2050, the Food and Agriculture Organization of the United Nations (FAO) predicted that meat consumption will rise 73 percent by 2050 and dairy consumption will increase by 53 percent from 2011 levels. The United States, China, and Brazil are the leading producers of meat. The United States, China, and India are the leading producers of cow's milk and chicken eggs.

Beef and veal; pork; and chicken and turkey broilers are the three major categories of meat production. After the 2001 recession caused a sharp drop in global meat production, it has been rising steadily to meet consumption demand. The U.S. Department of Agriculture (USDA) Economic Research Service (ERS) predicted that consumption of all meat will increase by an average of 1.6 percent annually from 2015 through 2024. Poultry will continue to experience the greatest growth with a 2.2 percent annual increase in consumption through 2024, driven by rising demand in developing countries. Global trade in broiler meat was estimated at 87.3 million metric tons (mmt) in 2015. Pork consumption grew 1.2 percent annually, with 2015 trade among major global traders exceeding 110.8 mmt, the USDA stated. Beef and veal, which totaled 59 mmt in 2015, were projected to see a 1.3 percent annual trading increase through 2024.

One concern is the greater resources in terms of feed and acreage needed to support meat production, as compared to crops. The FAO warns that improvements in meat production efficiency and disease control will be needed to meet the growing consumption demands of a population expected to exceed 9 billion by 2050.

According to the FAO's October 2014 *Food Outlook*, world milk production had grown at an average rate of 2 percent during the early 2010s. Production climbed by 2.4 percent annually in 2014 to an estimated 792 million tons. Dairy was not a major export commodity, but it was a growing market, increasing by 4.6 percent in 2014 to 72 mmt. About half of dairy exports were to Asian markets, with Africa receiving about 15 percent.

ORGANIZATION AND STRUCTURE

Market Segments.

Beef Cattle. The beef cattle industry thrives in countries with large areas of pasture, such as the United States, Argentina, Brazil, China, and New Zealand. A cow and her calf may be supported on as little as one acre of land in areas of abundant rainfall or irrigation or on as much as 600 to 700 acres on desert ranches.

Production of cattle, from birth to slaughter, takes between 18 months and 2 years. During the first six to eight months, beef cows nurse their calves on a farm or ranch. As they are weaned, calves in most countries begin to graze on grassland until they are large enough to be slaughtered. In the United States, however, the vast majority of older yearling calves are confined in feedlots and fattened, or "finished," on a high-energy diet of grain. While the majority of U.S. beef is grown in feedlots, some foreign producers use feedlots to produce the highly marbled beef prized by many consumers, particularly in Japan and the United States. For example, New Zealand

opened its first commercial grain feedlot in 1991 to supply such beef to Japan. Demand for meat from grass-fed cattle, which is considerably leaner than feedlot beef, was increasing as healthy eating trends gained importance.

Most beef is consumed in the nation where it is produced, with only 9 mmt of 58 mmt total worldwide production being exported in 2013. According to the USDA Foreign Agricultural Service (FAS), the United States was the leading producer and consumer of beef, followed by Brazil, the EU, and China. New Zealand and Australia were among the nations that exported a majority of the beef they produced, while India was showing the largest growth in exports in the mid-2010s. "Between 2015 and 2024, beef imports by the major beef importing countries are projected to increase by 2.6 million tons, reaching 10.1 million tons in 2024," the USDA stated. "Exports of lower-priced beef from India and Brazil, mostly to a number of low- and middle-income countries, account for almost three-quarters of the projected increase in exports by the major beef traders."

Dairy Farms. Milk production is more efficient in cooler climates, such as northern Europe and the northern United States. Since milk must be continually refrigerated while it is processed and sent to retail outlets, dairy farms typically operate locally or regionally. While international trade in milk is limited, products made from milk, such as cheese, are widely exported. Argentina, Australia, the EU, New Zealand, and the United States are the leading exporters of dairy products. New Zealand is the dominant exporter of butter, and the United States exports a significant amount of cheese to South Korea, Mexico, and China.

Poultry. The sharp increase in chicken consumption that began in the 1960s was a result of the low production and consumer costs of poultry compared to other meats. The world's poultry producers were able to drive down production costs by improving feed efficiency. Consumers also purchased more chicken because it was highly nutritious.

Poultry producers in many countries evolved into large, vertically integrated production-processing-marketing companies. World poultry production is divided into three major segments of broiler chicken, turkey, and other poultry, such as duck and goose. Broilers accounted for around 68 percent of the world market, turkey accounted for 8.5 percent, and other poultry accounted for 24.5 percent. While more than 50 countries were significant poultry producers, the top 10 accounted for more than 80 percent of world output of broiler meat in 2014. The United States, China, Brazil, and the European Union were the leading producers of broiler meat throughout the mid-2010s. Brazil

was the top poultry exporter, followed by the United States, the EU, Thailand, China and Turkey in 2014.

Eggs. Some farms continue to produce eggs from “free range” chickens that are allowed to roam outside, but the majority of eggs are produced in vast factory farms where hens are kept in wire-floored cages. In the United States and other industrialized countries, technology plays a large role in egg production. Hens are bred carefully to maximize egg-producing characteristics, such as early maturity, efficient use of feed, and production of white eggs. The laying house of the early twenty-first century is typically automated with mechanized feeders, sanitizers, egg collectors, and temperature and light controls. An egg-production flock can be between 100,000 and 1 million hens. While most eggs are sold fresh in the shell, a growing percentage are pasteurized and sold in liquid, frozen, or dried forms. Global egg production was estimated at 70.4 million tons for 2015 and was projected to rise to 89.9 million tons by 2030, according to the FAO.

Hogs. Pork production traditionally has been highly segmented, with different farms and firms performing the separate functions of raising hogs, slaughtering, processing, and retailing. However, the global pork industry, like the chicken industry, consolidated functions and vertically integrated them in a small number of large firms. Hog farming also became increasingly industrialized, with a large number of hogs fed and housed in confinement rather than being free to roam outside. In order to manage high-volume hog farms, producers used sophisticated genetic breeding programs, nutritional science, and computerized record-keeping systems. Ownership of high-volume hog farms, particularly by large agricultural companies, was controversial in areas of the United States like Iowa where small family farms continued to operate.

China produced and consumed over half of all pork throughout the earliest years of the twenty-first century. China produced 56.7 mmt and consumed 57.2 mmt in 2014 of the roughly 110 mmt in the global market. The EU accounted for about one-fifth of production, or 22.4 mmt. Growth was at a fairly consistent rate over that period. The United States was the only other significant producer at almost 10.4 mmt of pork. The United States, the EU, and Canada were the major exporters. Global trade growth in the early 2010s was primarily due to rising demand in East Asia and North America.

BACKGROUND AND DEVELOPMENT

For over 30 years, pork has surpassed beef as the most popular meat based on carcass weight produced, accounting for 40 percent of global meat production in 2011. In 2000 pork production was listed by the FAO at 86.2 mmt, and at 108.6 mmt in 2011. By 1999 chicken

matched cattle production, with each producing 55.5 mmt, and chicken has remained the second most popular meat. Since that time, chicken production has surged ahead to 90 mmt in 2011, while cattle production lagged behind at 63 mmt. In major global markets for 2015, according to the USDA, pork production was estimated at 110.8 million tons; poultry, 87.3 million tons; and beef, 59 million tons.

Beef. Great Britain, and potentially all beef producers, faced a beef production crisis in 1986 that escalated in late 1995. Researchers discovered that cows fed with animal parts could develop bovine spongiform encephalopathy (BSE), also known as mad cow disease. The European Union banned beef imports from Great Britain, and the British Agricultural Ministry ordered the slaughter of millions of British beef cattle, which cost the country US\$10 billion. Scientists believed that consumption of diseased beef could lead to related diseases in humans; consequently, the European Union persuaded Great Britain to stop using animal parts in livestock feed. By March 2002 more than 180,000 bovines had been slaughtered after contracting the disease or being exposed to it.

BSE was not confined to Great Britain. Japan had one confirmed case of a carcass infected with mad cow disease. In 2003 the disease surfaced in Canada, and the United States confirmed one case, which resulted in a ban that threatened that country’s US\$3.6 billion export business in beef and veal and restricted exports to Mexico and Japan until 2004 and 2006, respectively. It was not until the end of 2013 that the United States announced it was lifting the ban on EU beef imports.

Argentina became a significant exporter of fresh grass-fed beef in the twenty-first century. For 60 years Argentina’s beef exports had been limited to cooked and processed beef, due to persistent bovine foot and mouth disease contamination. The ban was lifted in 1997; however, a recurrence of the disease in 2001 resulted in another setback. After Argentina’s herds were declared officially disease-free, exports increased from 386,000 metric tons (mt) in 2003 to 623,000 mt in 2004. Australia was the world’s leading exporter of beef in 2002 at 1.4 mmt, but Brazil took the lead in 2004 with 1.6 mmt.

Dairy Products. Worldwide milk production rose from 490.1 mmt in 2000 to 614.6 mmt in 2011. India was the world’s leading milk producer due to rising domestic consumption. Its production more than doubled in the last 20 years from 53.9 mmt in 1990 to 127 mmt in 2011, or 17 percent of global production. The EU produced 146 mmt, dominating cheese production and exports.