

Moving Up the Food Chain

For most of the time that human beings have walked the earth, we lived as hunter-gatherers. The share of the human diet that came from hunting versus gathering varied with geographic location, hunting skills, and the season of the year. During the northern hemisphere winter, for instance, when there was little food to gather, people there depended heavily on hunting for survival. Our long history as hunter-gatherers left us with an appetite for animal protein that continues to shape diets today.

As recently as the closing half of the last century, a large part of the growth in demand for animal protein was still satisfied by the rising output of two natural systems: oceanic fisheries and rangelands. Between 1950 and 1990, the oceanic fish catch climbed from 17 million to 84 million tons, a nearly fivefold gain. During this period, the seafood catch per person more than doubled, climbing from 15 to 35 pounds.¹

This was the golden age of oceanic fisheries. The catch grew rapidly as fishing technologies evolved and as refrigerated processing ships began to accompany fishing fleets, enabling them to operate in distant waters. Unfortunately, the human appetite for seafood has outgrown the sustainable yield of oceanic fisheries. Today

four fifths of fisheries are being fished at or beyond their sustainable capacity. As a result, many are in decline and some have collapsed.²

Rangelands are also essentially natural systems. Located mostly in semiarid regions too dry to sustain agriculture, they are vast—covering roughly twice the area planted to crops. In some countries, such as Brazil and Argentina, beef cattle are almost entirely grass-fed. In others, such as the United States and those in Europe, beef is produced with a combination of grass and grain.³

In every society where incomes have risen, the appetite for meat, milk, eggs, and seafood has generated an enormous growth in animal protein consumption. Today some 3 billion people are moving up the food chain. For people living at subsistence level, 60 percent or more of their calories typically come from a single starchy food staple such as rice, wheat, or corn. As incomes rise, diets are diversified with the addition of more animal protein.⁴

World consumption of meat climbed from just under 50 million tons in 1950 to 280 million tons in 2010, more than a fivefold increase. Meanwhile, consumption per person went from 38 pounds to 88 pounds a year. The growth in consumption during this 60-year span was concentrated in the industrial and newly industrializing countries.⁵

The type of animal protein that people choose to eat depends heavily on geography. Countries that are land-rich with vast grasslands—including the United States, Brazil, Argentina, and Russia—depend heavily on beef or—as in Australia and Kazakhstan—mutton. Countries that are more densely populated and lack extensive grazing lands have historically relied much more on pork. Among these are Germany, Poland, and China. Island countries and those with long shorelines, such as Japan and Norway, have turned to the oceans for their animal protein.⁶

Over time, global patterns of meat consumption

have changed. In 1950, beef and pork totally dominated, leaving poultry a distant third. From 1950 until 1980, beef and pork production increased more or less apace. Beef production was pressing against the limits of grasslands, however, and more cattle were put in feedlots. Because cattle are not efficient in converting grain into meat, world beef production, which climbed from 19 million tons in 1950 to 53 million in 1990, has not expanded much since then. In contrast, chickens are highly efficient in converting grain into meat. As a result, world poultry production, which grew slowly at first, accelerated, overtaking beef in 1997. (See Figure 3–1.)⁷

The world's top two meat consumers are China and the United States. The United States was the leader until 1992, when it was overtaken by China. (See Figure 3–2.) As of 2012, twice as much meat is eaten in China as in the United States—71 million tons versus 35 million.⁸

The huge growth in meat consumption in China,

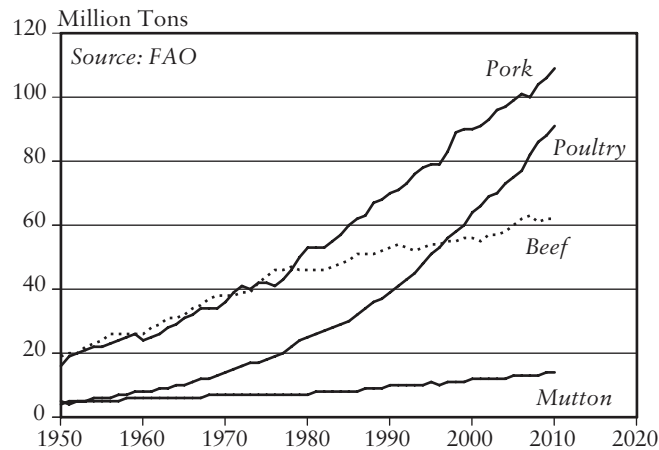


Figure 3–1. *World Meat Production by Type, 1950–2010*

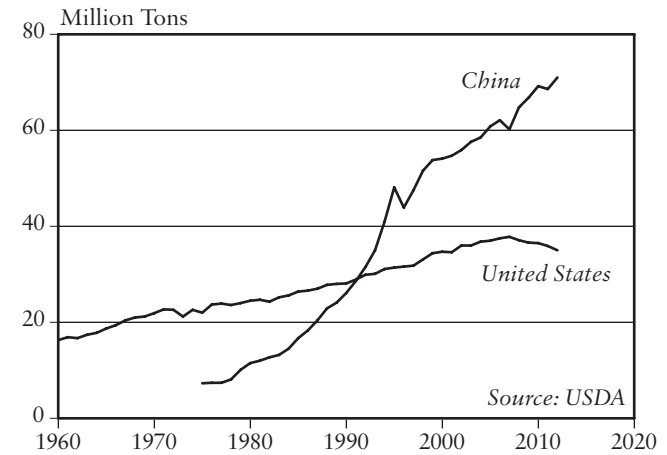


Figure 3–2. *Meat Consumption in China and the United States, 1960–2012*

mostly of pork, came after the economic reforms in 1978, when large production teams were replaced by family farms. Today pork is the world's leading meat, and half of it is eaten in China. The heavy reliance on pork in China is not new. In an effort to minimize waste, village families in China have a long-standing tradition of keeping a pig that is fed kitchen and table wastes. When the pig matures, it is butchered and eaten and replaced with another small, recently weaned, pig. Even though large-scale commercial hog production now dominates output in urbanizing China, pork's prominent place in the Chinese diet has deep cultural roots.⁹

With China's 1.35 billion people clamoring for more pork, production there climbed from 9 million tons in 1978, the year of the economic reforms, to 52 million tons in 2012. U.S. pork production rose from 6 million to 8 million tons during the same period.¹⁰

These shifts in world meat consumption have been

driven primarily by widely differing production costs, with consumers moving toward the lower-cost offerings. In 1950, poultry was expensive and production was limited, roughly the same as mutton. But from mid-century onward, advances in the efficiency of poultry production dropped the price to where more and more people could afford it. In the United States—where a half-century ago it was something special, usually served at Sunday dinner—the low price of chicken now makes it the meat of choice for everyday consumption.¹¹

Perhaps the greatest restructuring is occurring with seafood consumption. Historically, as the demand for seafood increased and fishing technologies advanced, coastal and island countries in particular began to rely more heavily on the oceans. As population pressure built up in Japan, more and more land was needed to produce its food staple, rice. By the early twentieth century, Japan was using virtually all its arable land to produce rice, leaving none to produce feed for livestock and poultry. So Japan turned to seafood to satisfy the growing demand for animal protein.¹²

Japan now consumes 8 million tons of seafood a year as part of its “fish and rice” diet. But with oceanic fisheries being pushed to their limits, there are few opportunities for other countries to turn seaward for protein in the same way. For example, if China’s per capita consumption of oceanic seafood were to reach the Japanese level, it would consume nearly the entire world catch.¹³

So although China is a leading claimant on oceanic fisheries, with an annual catch of 15 million tons, it has turned primarily to fish farming to meet its fast-growing seafood needs. As of 2010, its aquacultural output—mainly carp and shellfish—totaled 37 million tons, more than the rest of the world combined. With incomes now rising in densely populated Asia, other countries are

following China’s lead. Among them are India, Thailand, and Viet Nam.¹⁴

Over the last 20 years, aquaculture has thus emerged as a major source of animal protein. Driven by the high efficiency with which omnivorous species such as carp, tilapia, and catfish convert grain into animal protein, world aquacultural output expanded more than fourfold between 1990 and 2010. (See Figure 3–3.) Early estimates indicate it eclipsed beef production worldwide in 2011.¹⁵

Not all aquacultural operations are environmentally beneficial. Some are both environmentally disruptive and inefficient in feed use, such as the farming of shrimp and salmon. These operations account for only a small share of the global farmed fish total, but they are growing fast. Shrimp farming often involves the destruction of coastal mangrove forests to create habitat for the shrimp. Salmon are inefficient in that they are fed other fish, usually as fishmeal, which comes either from fish processing plant

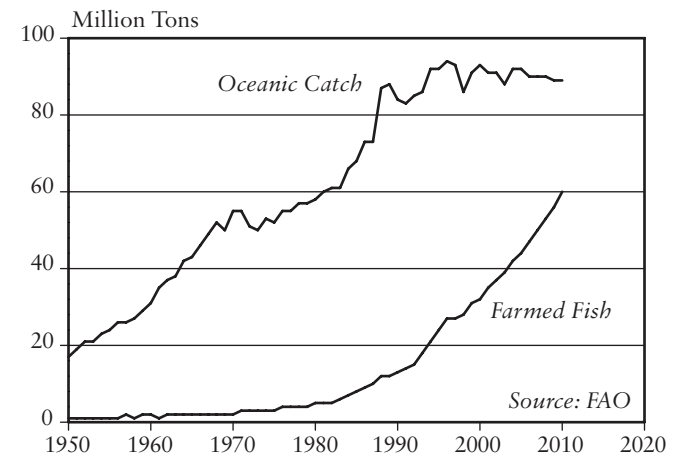


Figure 3–3. World Oceanic Fish Catch and Farmed Fish Production, 1950–2010

wastes or from low-value fish caught specifically for this purpose.¹⁶

As people consume more meat, milk, eggs, and farmed fish, indirect grain consumption rises. Comparing grain use per person in India and the United States provides some idea of how much grain it takes to move up the food chain. In low-income India—where annual grain consumption totals 380 pounds per person, or roughly 1 pound a day—nearly all grain must be eaten directly to satisfy basic food energy needs. Only 4 percent is converted into animal protein. Not surprisingly, the consumption of most livestock products in India is rather low. Milk, egg, and poultry consumption, however, are beginning to rise, particularly among India's expanding middle class.¹⁷

The average American, in contrast, consumes roughly 1,400 pounds of grain per year, four fifths of it indirectly in the form of meat, milk, and eggs. Thus the total grain consumption per person in the United States is nearly four times that in India.¹⁸

Pork and poultry meat are the world's leading sources of land-based animal protein, but eggs are not far behind, with 69 million tons produced in 2010. Egg production has grown steadily over the last half-century and appears likely to continue to do so. Eggs are a relatively inexpensive but valuable serving size source of protein. Worldwide, people on average eat three eggs per week.¹⁹

As with pork, egg production in China has grown at an explosive pace, going from 6 million tons in 1990 to 24 million tons in 2010. As a result, China totally dominates world egg production. The United States is a distant second, with just over 5 million tons per year. India ranks third, with 3 million tons.²⁰

Yet consumers in some countries live high on the food chain but use relatively little grain to feed animals. For example, the Japanese use only moderate amounts of

feedgrains because their protein intake is dominated by the oceanic fish catch. This is also the case with Argentina and Brazil, where nearly all the beef is grass-fed.²¹

In recent decades, Brazil, the world's third ranking meat consumer, has experienced a marked restructuring of its meat consumption pattern. In 1960 beef was totally dominant, with pork a distant second and poultry almost nonexistent. By 2000, to the surprise of many, the fast-growing consumption of poultry in Brazil eclipsed that of beef. Pork consumption is still far behind.²²

With the world's grasslands being grazed at their limits or beyond, additional beef production now comes largely from putting more cattle in feedlots. A steer in a feedlot requires 7 pounds of grain for each pound of weight gain. For pork, each pound of additional live weight requires 3.5 pounds. For poultry, it is just over 2. For eggs the ratio is 2 to 1. For carp in China and India and catfish in the United States, it takes less than 2 pounds of feed for each pound of additional weight gain. Thus the worldwide change in patterns of meat consumption reflects the costs of meat production, which in turn reflects the widely varying levels of efficiency with which cattle, pigs, chickens, and farmed fish convert grain into protein.²³

Recent production trends give some sense of where the world is headed. Between 1990 and 2010, growth in beef production averaged less than 1 percent a year. Pork, meanwhile, expanded at over 2 percent annually, eggs at nearly 3 percent, and poultry at 4 percent. Aquacultural output, which sets the gold standard in grain conversion efficiency, expanded by nearly 8 percent a year, climbing from 13 million tons in 1990 to 60 million tons in 2010.²⁴

The share of the world grain harvest used for feeding livestock, poultry, and farmed fish has remained remarkably stable over the last few decades. One reason it has not risen much is the practice, now worldwide, of incorporating

soybean meal into feed rations at a ratio of roughly 1 part soybean meal to 4 parts grain. This leads to a much more efficient conversion of grain into animal protein. As the demand for animal protein has climbed over the last half-century, demand for soybeans has climbed even faster. (See Chapter 9.)²⁵

Worldwide, roughly 35 percent of the 2.3-billion-ton annual grain harvest is used for feed. In contrast, nearly all of the soybean harvest ends up as feed. Both pork and poultry output depend heavily on grain, whereas beef and milk production depend more on a combination of grass and grain.²⁶

The world's three largest meat producers—China, the United States, and Brazil—rely heavily on soybean meal as a protein supplement in feed rations. Indeed, the share of soybean meal in feed in each country now ranges between 15 and 18 percent.²⁷

The mounting pressure on land and water resources has led to some promising new animal protein production models, one of which is milk production in India. Since 1970, India's milk production has increased nearly sixfold, jumping from 21 million to 117 million tons. In 1997, India overtook the United States in dairy production, making it the world's leading milk producer.²⁸

The spark for this explosive growth came in 1965 when an enterprising young Indian, Dr. Verghese Kurien, organized the National Dairy Development Board, an umbrella organization of dairy cooperatives. The co-op's principal purpose was to market the milk from the two or three cows typically owned by each village family. It was these dairy cooperatives that provided the link between the growing appetite for dairy products and the millions of village families who had only a small marketable surplus.²⁹

Creating the market for milk spurred the sixfold growth in output. In a country where protein shortages stunt the

growth of so many children, expanding the milk supply from less than half a cup per person a day 25 years ago to more than a cup today represents a major advance.³⁰

What is unique here is that India has built the world's largest dairy industry almost entirely on roughage, mostly crop residues—wheat straw, rice straw, and corn stalks—and grass collected from the roadside. Cows are often stall-fed with crop residues or grass gathered daily and brought to them.³¹

A second relatively recent protein production model, which also relies on ruminants, is one developed in China, principally in four provinces of central eastern China—Hebei, Shandong, Henan, and Anhui—where double cropping of winter wheat and corn is common. Once the winter wheat matures and ripens in early summer, it must be harvested quickly so that the seedbed can be prepared for corn planting. The straw that is removed from the land prior to preparing the seedbed is fed to cattle, as are the cornstalks left after the corn harvest in late fall. By supplementing this roughage with small amounts of nitrogen, typically in the form of urea, the microflora in the complex four-stomach digestive system of cattle can convert roughage efficiently into animal protein.³²

This practice enables these four crop-producing provinces to produce much of the country's beef as well. This central eastern region of China, dubbed the Beef Belt by Chinese officials, is producing large quantities of animal protein using only roughage. This use of crop residues to produce milk in India and beef in China means farmers are reaping a second harvest from the original crop.³³

Another highly efficient animal protein production model, one that has evolved in China over the centuries, is found in aquaculture. In a carp polyculture production system, four species of carp are grown together. One species feeds on phytoplankton. One feeds on zooplankton. A

third feeds on aquatic grass. And the fourth is a bottom feeder. These four species thus form a small ecosystem, with each filling a particular niche. This multispecies system accounts for the major part of China's carp harvest of 16 million tons in 2011.³⁴

Although these three protein production models have evolved in India and China, both densely populated nations, they may find a place in other parts of the world as population pressures intensify and as people seek new ways to convert plant products into animal protein.

Looking to the future, there are some rather obvious shifts occurring in the pattern of world meat consumption. These are largely driven by an ongoing shift from the less efficient converter of grain into animal protein, such as feedlot beef, toward the more efficient converters, such as farmed fish and poultry. If recent trends continue, poultry production, which has already eclipsed beef, will likely overtake pork in 2020 or shortly thereafter, making poultry the world's leading meat. Within a few years, the production of farmed fish is likely to overtake both poultry and pork, becoming the world's leading source of animal protein by 2023.³⁵

In the United States, meat consumption, which had climbed steadily for over half a century, peaked in 2007, dropping 6 percent by 2012. This peak and decline were not widely anticipated. Among the contributing factors are high feed prices and, hence, meat prices; lingering uncertainty by consumers about the economic recovery; and a growing awareness among consumers of the negative health consequences of eating too much meat, including heart disease, cancer, and obesity. There is also growing opposition by animal rights and environmental groups to the inhumane production methods and pollution associated with factory farming. For one reason or another, Americans are reducing their consumption of meat. The United States

seems to be the first among the more populous countries to experience such an abrupt decline—one that appears likely to become a longer-term trend.³⁶

People with the longest life expectancy are not those who live very low or very high on the food chain but those who occupy an intermediate position. Italians, who live lower on the food chain than Americans do, can expect to live for 81 years, compared with American life expectancy of 79. Italians benefit from what is commonly described as the Mediterranean diet, one that includes livestock and poultry but in moderate amounts.³⁷

Although the world has had many years of experience in feeding nearly 80 million more people each year, it has much less experience with also providing for 3 billion people with rising incomes who want to move up the food chain and consume more grain intensive products. Whereas population growth generates demand for wheat and rice, humanities' two food staples, it is rising affluence that is driving growth in the demand for corn, the world's feedgrain. Historically, world corn and wheat production trends moved more or less together from 1950 until 2000. But then corn took off, climbing to 960 million tons in 2011 while wheat remained under 700 million tons.³⁸

It is the increase in consumption of livestock products plus the conversion of grain into fuel that have boosted the annual growth in world grain demand from the roughly 20 million tons a decade ago to over 40 million tons in recent years. As incomes continue to rise, the pressure on farmers to produce enough grain and soybeans to satisfy the growing appetite for livestock and poultry products will only intensify.³⁹

Data, endnotes, and additional resources can be found at Earth Policy Institute, www.earth-policy.org.