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Grain, a Basic Food

by KENNETH L. MURRAY

SEVENTY PERCENT of the harvested acreage of the whole world—1.6 billion acres—is used to grow grain. That is more than one-half acre and one-third of a ton of grain for each person in the world.

Grain is a basic food and always has been. Grain provides directly roughly half the calories of the world's 3 billion people. A large portion of the other 50 percent comes indirectly from grain—the grain that has been converted into meat, milk, eggs, and other animal products.

Many countries have been expanding their production, which averaged approximately 650 million tons in 1949-1953 and more than 900 million tons in recent years. The greatest increases are in corn, rice, and wheat. Barley and sorghum are of lesser importance, but their production also has increased rapidly.

Oats and rye are declining in importance—oats because there are fewer horses and rye because less of it is used for bread in Europe.

The giants in grain production are the United States, the Soviet Union, and China, which together grow more than two-fifths of the grain.

The United States produces about 170 million tons of grain each year—almost 1 ton for each inhabitant. Our production far surpasses our domestic needs. A large share, about 1 ton of

every 5 tons produced, is exported. Our abundant grain supplies have become important in our trade relations with other countries. They are a source of foreign exchange earnings and one of our "foods for peace."

MAN'S USE of grain as a food dates from the earliest civilizations. The grains are believed to have been among the first crops cultivated. Historians generally cite Asia as the area where the primitive wheats, barley, rye, and rice originated. Corn may have originated in Mexico or Central America and sorghum in tropical Africa. Oats have been traced to a European origin.

Wheat and barley may have been grown in the Mediterranean region as long ago as the late Bronze Age. Barley was being used then as an animal feed. People at first ate grain hulls and all. Later they began to remove the hulls.

The first food from wheat was in the form of boiled porridge. Later, wheat was used to make an unleavened flatbread, for which the kernels are ground or cracked, water is added, and the dough is baked on an open fire or fried. Flatbread is still popular in parts of Asia, Africa, and Europe. Corn, barley, and sometimes wheat and other grains generally are used to make flatbread. Unlike wheat and rye, barley and corn cannot be used for dough that is to be leavened, or raised.

The first raised-bread loaves may have been made by the Egyptians as early as 2600 B.C. Yeast generally is used as the agent to raise bread. Gases produced by the yeast and retained in the dough cause the loaf to raise. Only wheat and rye flours have the ability to retain these gases, but rye is inferior in leavening properties.

The book, *Breads, White and Brown*, by R. A. McCance and E. M. Widowson, points out that "the Greeks and the Romans seemed to have recognized, as we do today, a hard wheat and a soft wheat with different baking properties and to have sown wheat in both autumn and spring."

All the grains we grow in the United States, except corn, were brought here by the early settlers. Corn was grown by the Indians, who taught the settlers how to cultivate it. At the time of the first census in 1839, corn production was almost 10 million tons. It has always been our leading grain.

Wheat was first grown in the United States in 1602 in Massachusetts on Elizabeth Island. Slightly more than 2 million tons of wheat were produced in the United States in 1839. The leading wheat States then were Ohio, Pennsylvania, and New York.

While wheat, barley, rye, corn, and other grains were developing in the Western Hemisphere, the Far Eastern civilizations were cultivating mainly rice and growing less of the other grains. Rice was grown in China 5 thousand years or so ago, but we do not know in which country rice was first grown. Rice has been a basic food in most of Asia for centuries.

In the United States, rice was successfully planted the first time about 1685 in the Carolinas. For some 100 years after that date, rice production in the United States was confined to the swampy regions of the Carolinas and Georgia. During the 19th century, other States began planting rice, and by 1889 Louisiana became the Nation's leading rice producer. Farmers in Texas, Arkansas, California, and Mississippi began to grow rice.

Production of rice requires relatively high temperatures during the growing season, an abundant supply of water (which can be supplied through irrigation), level and well-drained land, and soil that can hold water. Those conditions exist in the rice-bowl region of Asia, which includes Thailand, Indochina, and Burma. Irrigation is needed for rice in the United States.

MANKIND HAS DEVELOPED and improved many types of grains and has put them to numerous uses. With this evolutionary process has come a general classification of grains according to their greatest usefulness.

We can make three broad groupings: Grain for direct consumption (in flour or in whole-kernel form); grain for livestock and poultry feed; and grain for industrial uses, such as the production of starch and alcohol. Wheat and rice are mostly in the first group.

Corn, barley, oats, sorghum, and millet are used mainly for feed. Of the relatively small amount of grain utilized in industrial processes, barley and corn are used most commonly.

THOUSANDS of varieties of wheat are grown throughout the world, but they all fall into one of two classifications—hard or soft.

Soft wheats usually are grown in places of relatively abundant rainfall.

Both soft red and soft white wheats are grown in the United States. Most of the soft red wheat is produced in Illinois, Indiana, Ohio, Missouri, and Pennsylvania, where rainfall averages about 40 inches a year.

The soft white wheat produced in the United States is grown mainly in Washington, Oregon, and Idaho.

Precipitation in those States averages below that in the soft red Wheat Belt, but the rainfall is more evenly distributed. The bulk of the wheat produced in western Europe and in Australia consists of soft varieties.

The soft wheats are used for bread, cookies, crackers, pastries, rolls, cake mixes, and other items. Soft-wheat flour, however, is not well suited to the manufacture of packaged bread as we know it in the United States, because bread made of soft wheat has a short shelf life—it would be stale before it could be delivered to the supermarket or doorstep. Places that grow soft wheat, such as western Europe, therefore import hard wheat to blend with domestic soft wheats for flour to be used to make bread that will keep.

French bread, which many people like, is made almost solely from the domestic soft wheat, but it must be eaten soon after it is made. Paris has countless breadshops, and French

families buy bread for each meal—not for a week.

In the countries that comprise the European Economic Community, a sizable amount of soft wheat, about 20 percent of production, is fed to livestock and poultry; the proportion is highest when the harvest season is wet and too much moisture causes wheat to sprout.

Hard wheat makes up the bulk of the wheat production in the United States, Canada, Argentina, and parts of western Asia and northern Africa. Wheat produced in the Soviet Union is generally considered hard.

Our main producers of hard wheat are Kansas, North Dakota, Montana, Nebraska, Washington, South Dakota, Minnesota, and Oklahoma, whose rainfall is considerably below that in the soft wheat States.

Hard wheat is used primarily for making bread. An exception is durum wheat, a variety of hard wheat used for making macaroni, spaghetti, and noodles. Durum wheat is grown in the United States, Canada, Spain, northern Africa and the Middle East, the Soviet Union, and Italy. A small amount is grown in France. The production of durum wheat in the United States is concentrated in North Dakota and South Dakota.

RICE VARIETIES number in the thousands. All fit into one of three groups—long-grain, medium-grain, and short-grain rice.

Long-grain rice, which has a kernel length about four or five times the width, is preferred by many consumers. It is clear and translucent; short-grain rice has a chalky look. Long-grain kernels tend to stick together much less than the short-grain varieties. Long-grain rice requires the longest growing season, needs more irrigation, and generally yields less than the others.

Milling long-grain rice is more expensive, and more grains break. It sells for more therefore than the short- and medium-grain sorts.

Medium-grain rice is somewhat less

desirable to most consumers, but it generally is preferred over short-grain rice and it costs less to produce and market than the long-grain varieties and therefore is the principal type grown in the United States.

Short-grain rice is the chalkiest variety and has the poorest separating qualities during cooking.

Because long-grain rice requires a lengthy growing season, it must be grown in semitropical and tropical climates. Production in southeastern Asia is principally long grain. Aromatic long-grain rice is grown in India and Pakistan; nonaromatic rice is grown in the United States. Short-grain rice is grown in Japan and other parts of northern Asia.

Rice milling differs from the milling of other grains in that a flour is not produced. The inedible hulls are merely removed. The rice remains in whole kernels; the kernels are not pulverized, as they are when wheat is milled.

There are different degrees of milling. If just the inedible hulls are removed, brown rice results—the kernel plus all the edible layers of bran. Rice in this form is most nutritious. Removal of the bran and polishing are further steps. Polished rice is preferred in many markets, including the United States.

THE COARSE GRAINS—all cereals except wheat and rice—are used mainly for animal feed and industrial purposes. Direct human consumption of coarse grains is relatively small. Rye is still a major food grain in central Europe, especially Germany and Poland, but its use for bread is declining. Corn is used for food extensively in Latin America, Africa, and eastern Europe.

Corn, the primary coarse grain, has three principal types: Dent, flint, and flour corn.

Dent corn, both yellow and white in color, forms the bulk of American and Mexican production. It mainly is used for feed, but some dent corn is used to make starch, alcohol, and other in-

dustrial products. Byproducts from the manufacture of starch from corn include corn sirup and corn oil. White dent corn is preferred for the production of starch. Some corn is milled in the United States to be eaten as meal, hominy, and grits.

Flint corn is grown principally in Latin America, Europe, and Asia. A small amount is grown in northern parts of the United States. Flint corn grown in Argentina has a higher content of carotene than the yellow dent corn grown in the United States. It produces a yellow fat in poultry and beef, and therefore enjoys a preference in some markets.

Flour corn is grown mainly in Latin America and in South Africa. Small amounts of flour corn are produced in drier sections of the United States.

White, blue, and variegated are the most common colors in flour corn. Its kernel is relatively soft and well suited to the manufacture of starch.

Two less common groups of corn are popcorn and sweet corn. Both are grown mainly in the United States and are little known elsewhere. Few Europeans share (or know about) our liking for corn-on-the-cob.

Barley is predominantly a feed grain, but a relatively large share goes into industrial uses. Barley is important in making malt, which is used principally in brewing beer and making alcohol and sirups. A small amount of barley is milled for food; this type is called pot or pearl barley.

Most of the oats harvested in the world is fed to livestock, especially horses and poultry. Some is used for food. Rolled oats, or oatmeal, is made generally by passing the oats between rollers.

Grain sorghums are a feed grain in the United States, but they are important as food in Africa and parts of India.

As to overall trends in grain consumption in the world, some factors are easily identified.

In countries with relatively high and

rising personal incomes, people eat less and less grain and more and more meat. In countries whose per capita incomes are low, diets tend to be made up mostly of cereal foods.

Feed grain is fed mainly to hogs and poultry. Beef and dairy cattle in the United States are commonly fed grain, but not in most other countries. In western Europe, for instance, cattle are mostly dual purpose (meat and milk) and are sustained on grazing rather than grain.

WHEAT, rice, and corn rank as the world's chief grains, measured in terms of production. Wheat has the largest acreage, but its yields are relatively low. Wheat and rice output has been approximately equal during the past few years; together they account for about half the world's production of grain. Corn is third; it accounts for about 20 percent. Barley, millet and sorghum, oats, and rye follow and form roughly 30 percent of world total.

THE WORLD PRODUCTION of wheat has averaged about 225 million tons. Wheat is grown in almost all countries, but in only 10 countries does average production exceed 5 million tons a year. They are the Soviet Union, the United States, China, Canada, France, India, Italy, Turkey, Australia, and Argentina.

Methods of production vary greatly. Planting, cultivation, and harvesting in mainland China, for example, still is principally handwork, as it was centuries ago. In the United States, Canada, Australia, and Argentina, those processes are highly mechanized.

The Soviet Union, the leading producer, has averaged about 50 million tons in recent years, although yields there are lower than in any of the other nine countries. The average in Russia is 12 bushels an acre. Production in the Soviet Union increased 54 percent between 1950-1954 and 1955-1959, but has stabilized since then, primarily because fewer acres have been planted to wheat. The new lands in

Siberia seem to have reached a peak in harvested grain acreage.

The total wheat production in the United States averaged about 33 million tons a year in the early sixties—a 10-percent increase over 1950-1954. The acreage needed to produce this grain has declined as a result of Government acreage allotments, but the yields have increased more than enough to offset the reduction in acreage. Wheat yields in the United States averaged 25 bushels an acre in the sixties, compared to 22 bushels in the early fifties.

Production in Canada has been relatively stable since 1950, but in 1961 a crop failure lowered production to 7.7 million tons, about half the average. Yields in Canada have not shown a tendency to increase, but seem to have stabilized at about 21 bushels an acre.

Production in France, the fifth largest grower, has risen sharply without any increase in acreage. A record crop of 14 million tons in 1962 was harvested in France; the average yield was 45 bushels an acre. Yields in some parts of northern France reached 90 bushels an acre; operations there are largely mechanized, and fertilizer is applied heavily. Also, optimum conditions prevailed during planting, growing, and harvesting.

India, Italy, and Turkey grow much wheat but generally not enough to meet their own needs. The Soviet Union, the United States, Canada, and France generally export large quantities of wheat. The Soviet Union has been a wheat exporter, but untoward weather conditions necessitated large imports in 1963-1964.

Australia and Argentina, where the wheat crop averages 7 million tons and 5 million tons, respectively, also produce more than enough for domestic needs and generally export some.

The highest wheat yields in the world are obtained in Europe. Average yields in the Netherlands reached 60 bushels an acre in 1960-1963. They were about 55 bushels in the United Kingdom, Belgium, Germany, and in

Ireland have had an average close to 50 bushels.

In western Europe as a whole, the average yields have been as high as 34 bushels an acre—compared to 24 bushels in eastern Europe, 14 in Asia, 11 in Africa, 16 in South America, and 18 in Oceania.

Among the factors that lead to variations in yields from country to country are the intensity of production and growing conditions. In countries in western Europe, wheat is grown intensively, fertilizer application is high, and farms are relatively small. In the United States and Canada, fertilizer generally is used more sparingly, and wheatfields seem endless. Growing conditions dictate the types grown and strongly influence yields. Soft winter wheats, for example, are adaptable to sections of relatively high moisture and rather mild winters.

Hard spring wheats cannot be grown in high-moisture areas and do not have the benefit of a start in the fall.

THE MAIN COARSE grains are corn, barley, oats, sorghum, and rye. World production of corn averages 190 million tons; barley, 80 million tons; oats, 50; and rye, 33.

The United States grows about half of the world's corn. Production was 70 million tons in 1950-1954 and 95 million tons in 1960-1962. This large rise in output has come although the acreage in corn was reduced. The average yield in the United States in 1950-1954 was 39 bushels an acre and 60 bushels in later years—the highest in the world. The use of hybrid corn seed has been a prime factor behind this large increase in yields.

Average yields in other major corn-producing countries have been: Brazil, 22 bushels an acre; Mexico, 14; Republic of South Africa, 21; Yugoslavia, 34; Argentina, 30; Rumania, 25; India, 15; Italy, 46; Hungary, 37. Average yields worldwide are about 30 bushels an acre.

The Soviet Union has ranked as the world's second largest producer of

corn. Production there has increased from about 5 million tons in the early fifties to almost 11 million tons.

The output of Brazil, the third corn producer, equals about 10 percent of the United States production, but has gone up from about 6 million tons in the early fifties to about 10 million tons in the sixties.

Mexico, the Republic of South Africa, Yugoslavia, Argentina, and Rumania harvest about 5 million tons a year each. All of them usually export corn.

Of the leading corn producers, only the United States planted hybrid seed almost exclusively in 1964.

BARLEY is second in importance among the coarse grains. The Soviet Union leads in production, and the United States is second.

Barley commonly is planted in the spring. The effect of a severe winter on fall-sown crops sometimes determines how many acres are planted to barley. In France in 1956-1957, for example, much of the winter wheat crop was winterkilled, and the fields were resown to barley in the spring.

The Soviet Union in 1962 harvested 15 million tons of barley—double the average in the early fifties. The increase was due primarily to an extension of barley acreage. Yields rose only slightly.

France, West Germany, and Denmark also increased their production of barley. A reduction in the planted acreage in the United States has been offset by higher yields.

Yields in Denmark have surpassed an average of 70 bushels an acre. The American average has been about 32 bushels; the Soviet Union's, about 18 bushels. The world average is about 25 bushels.

OATS is the only major grain whose production has dropped in recent years. The United States' volume, about 15 million tons, has fallen off by almost 5 million tons since the early fifties. In Canada it has fluctu-

ated but reached a high level of more than 7 million tons in 1962. Production in the Soviet Union declined from 12 million tons in the early fifties to 6 million tons in 1962.

Average yields of oats approximate 43 bushels an acre in the United States, 40 in Canada, 22 in the Soviet Union, and 37 worldwide.

Acreage under rye has been reduced, but yields have increased enough to offset the reduction. Europe produces about half of the world's rye crop. Poland, the largest producer, averages 8 million tons a year—one-fourth of the world total.

Grain sorghums, although still junior to corn and barley, have had a great upsurge among growers in the United States, which has become the world's largest producer. American production has tripled since the early fifties and has averaged about 13 million tons in later years. India is a large producer—about 10 million to 12 million tons. Grain sorghums are popular also in Argentina and the Sudan.

RICE is to the Asian countries what wheat is to the Western World. It is a staple in the diet from Pakistan to Japan.

China and India, the most populous countries, are leading producers of rice. The Food and Agriculture Organization estimated that China produces about 80 million tons a year. Production in India has averaged slightly more than 50 million tons. China and India thus grow more than half the world's rice, which is set at 200 million tons a year. India and China, however, export little or no rice; in fact, India imports about 500 thousand tons annually.

Rice is grown in China and India much as it has been for hundreds of years. Labor is cheap, and planting, cultivating, and harvesting are done by hand.

Japan, Pakistan, and Indonesia each produces 14 million to 16 million tons of rice a year. Each, however, has had to import rice to meet domestic needs.

The rice bowl of the world includes Burma, Thailand, and South Vietnam, an area well suited to growing rice. Production in each has been 5 million to 8 million tons, but that meets domestic needs and leaves some for export. The average family farm in the rice bowl grows rice on 15 acres and markets about two-thirds of its output.

Brazil, the United States, and the United Arab Republic also grow rice. Production in Brazil is partly mechanized, but hand labor is used for harvesting and some cultivating. The United States is relatively unimportant in the total world production but has led in introducing new technology. We have developed laborsaving machines, higher yielding varieties, more profitable methods of fertilization, more effective irrigation practices, and advanced marketing techniques. Production in the United States is relatively stable at about 2.5 million tons, about 1 percent of the world total.

Grain is the most important farm commodity in world commerce. Global exports of grain have approximated one-sixth of the total value of world agricultural exports.

Total world grain exports have ranged between 60 million and 80 million tons. Of that, wheat has accounted for almost 60 percent; barley, about 10 percent; corn, 17 percent; and rice, 9.

Grain is a good deal less perishable than most other food commodities in international trade. The less-developed countries whose food distribution systems are not fully efficient have found it less difficult to handle imports of grain than goods harder to store.

The United States is the leading grain exporter. American exports of wheat and flour have been about 40 percent of the world's total exports of those commodities. Our share in the international trade of corn is even higher—slightly more than 50 percent of the total world exports. We account for more than 75 percent of the world total sorghum exports and 30 percent of the world's barley exports. In total,

the United States exports 30 million to 35 million tons of grain annually—the production of one in every five acres.

About 70 percent of United States wheat exports (about 14 million tons) are delivered to countries under Government programs. The main receivers of this wheat have been India, Pakistan, Brazil, Turkey, and the United Arab Republic. The remaining 30 percent of our wheat exports not under Government programs are commercially sold, mainly to countries of the European Economic Community, the United Kingdom, and Japan.

United States exports of feed grains are mainly for commercial markets.

The major outlets are the United Kingdom, the European Economic Community, and Japan. Canada is an important market for corn, the major feed grain we export.

Canada is the second largest grain exporter; her shipments have averaged 9 million tons of wheat and more than 1 million tons of barley.

Canadian exports of wheat are in direct competition with United States exports, especially in the important western European markets, which require hard wheat for blending with domestic soft wheats. Exports of wheat to China and the Soviet Union have become important to the Canadians.

Canadian exports of barley have been about 18 percent of the world total. The major markets for Canadian barley are in western Europe. Canada also exports grain under a Government program, but the volume is small.

Australian exports of wheat have averaged more than 5 million tons since 1960. The main markets have been China, India, Japan, the United Kingdom, other western European countries, and the Soviet Union.

Australian wheat is called filler wheat and (unlike the hard wheats exported by Canada and the United States) is not suited for blending with soft wheat to improve quality of flour. Australia also exports about 1 million tons of coarse grains.

Argentina follows Australia in vol-

ume of grain exports. Both corn and wheat shipments average somewhat more than 2 million tons a year. Argentina's principal wheat markets are Brazil and western Europe. Argentine corn goes mainly to Europe, especially Italy. The Italian market shows a preference for the high carotene content of the Argentine flint corn. Argentina also exports relatively small amounts of sorghums and oats.

The Soviet Union, which has been a regular wheat exporter, had to import large amounts of wheat from Canada, Australia, and the United States in 1963-1964 because of small crops in 1963. Major markets for Soviet wheat have been Poland, Czechoslovakia, East Germany, and some western European countries.

France has become an important exporter of wheat, barley, and corn. French markets include its European Economic Community partners, northern Africa, eastern Europe, the United Kingdom, and China.

The Republic of South Africa has become a leading corn exporter, notably to the European Economic Community, the United Kingdom, and Japan. South African corn exports are principally white flint, which enjoys a preference in starch manufacture.

Burma and Thailand are the world's leading rice exporters. World rice exports have averaged about 6.5 million tons a year, or less than one-fifth of wheat exports. Burmese rice exports have been consistently above 1.5 million tons. Thailand's exports have ranged between 1.1 and 1.6 million tons.

The United States is third in rice exports, averaging about 900 thousand tons. Other regular rice exporters are Cambodia, the United Arab Republic, and Italy. The major importers of rice are in the Far East and western Europe.

KENNETH L. MURRAY joined the Department of Agriculture in 1958. He is an agricultural economist in the Grain and Feed Division, Foreign Agricultural Service.