

# Rye Production and Uses Worldwide<sup>1</sup>

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Rye (*Secale cereale* L.) is second only to wheat among the grains most commonly used in the production of bread. It is also an important cereal grain for production of mixed animal feeds. Because it is extremely winter hardy and can grow in sandy soils with low fertility, rye can be cultivated in areas that are generally not suitable for other cereal crops. Most of the rye produced worldwide is grown in cool temperate zones, but it can also be grown in semiarid regions near deserts and at high altitudes. Several general reviews on rye are available (1, 5, 7, 8).

## Origin and History

Rye's primary center of origin is not known precisely, but it appears to be southwestern Asia, essentially the same area of origin as common wheat, barley, and oat (3). Rye is not as old as wheat, and there is no evidence of cultivated rye in ancient Egyptian monuments nor is it mentioned in

any of the ancient writings. It is mentioned in early northern European writings, suggesting that it was first cultivated in this area. Rye grains found in Neolithic sites in Austria and Poland are considered to be of "wild" origin.

Rye moved from its center of origin into northern Europe sometime during the first millennium B.C.E. The exact route of the migration is unknown, although one possible route is from Asia Minor northward into Russia and then westward into Poland and Germany (6, 10). According to Popov (9; quoted in Deodikar [3]), a second possible route of migration is from Turkey across the Balkan Peninsula into north-central Europe. From there, rye gradually spread throughout most of Europe and was eventually brought to North America and western South America by European settlers during the sixteenth and seventeenth centuries. During this same period, it gradually spread across the southern fringe of Russia and into Siberia. During the nineteenth and twentieth centuries, it was introduced into Argentina, southern Brazil, Uruguay, Australia, and South Africa. Today, rye is grown around the world, but the greatest concentration remains in Poland, Germany, western Russia, Belarus, and Ukraine.

## Classification

Rye is a member of the grass family Gramineae and the genus *Secale*, of which *S. cereale* is the most commonly cultivated

species. A small quantity of *S. fragile* is grown in southwestern Asia. The wild progenitor has not been definitely identified, although some taxonomists believe that modern rye evolved from *S. montanum* Guss., a perennial grass that grows wild in southern Europe and central Asia.

Most cultivated rye contains seven pairs of somatic chromosomes. Artificially produced tetraploid rye, which contains 14 pairs of chromosomes, is grown in limited amounts in Europe.

The number of different cultivars of rye grown around the world is relatively small, especially compared with wheat. Considerably less effort has been expended in the improvement and development of rye cultivars than of most other cereals. Because rye is a cross-pollinated crop, it is extremely difficult to keep rye cultivars genetically "pure."

Most rye is grown as a fall-sown annual crop, generally called "winter rye." Because of its superior winter hardiness, winter rye can be grown successfully in areas where the climate is too severe for winter wheat or barley. Some spring rye is grown in areas where the winters are too severe even for the most hardy winter rye cultivars, e.g., in Canada. Spring cultivars are generally inferior in agronomic characteristics (e.g., yield) and end-use quality.

## Worldwide Production

Around the world, the area of cultivated land dedicated to growing rye (11) has

<sup>1</sup> Adapted from a chapter by the author in *Rye: Production, Chemistry, and Technology*, 2nd ed., published by AACC, St. Paul, MN, 2001.

decreased substantially since the 1970s. In 1986, 24 million hectares were harvested; by 1996, the figure was 17 million hectares, a drop of 29%. During the same period, total production decreased from 30 to 22 million metric tons, a drop of about 27%. The decrease in cultivated area was largely offset by an increase in yield. Yields during the late 1960s were as low as 11.5 centals per hectare. During the 1990s, yields were approximately 18 centals per hectare, an increase of 57%. This significant increase in yield was achieved through improvement of agronomic practices, especially in the use of chemical fertilizers and crop rotation, decline in the use of less fertile land, and development of high-yield cultivars.

Of the eight major cereal crops, rye was eighth in production during the late 1980s and the 1990s (Table I). While production of rye has declined somewhat during the 1990s, production of the three major cereals, wheat, rice, and maize, has increased.

Rye is a particularly important crop in Poland, Germany, and three republics of the former Soviet Union (Table II). In 1996, more than 80% of the world's rye was grown in these five countries, where the grain forms a substantial portion of the human and animal diets. In Poland, rye was the leading cereal crop, exceeding wheat by nearly 50%. In Germany, rye accounted for almost 40% of the combined wheat and rye production. Rye occupies an important economic position in several other countries as well.

In spite of continued world food shortages, it is not expected that rye production will increase in the near future. However, because of the winter hardness of the plant and its ability to grow on soils with marginal fertility, interest in the crop should continue to be high, and rye should continue to be an important crop.

## Uses

Rye is a highly versatile crop. As a green plant, it is used as livestock pasture and as green manure in crop rotations; as grain, it is used for livestock feed and as feedstock in alcohol distilling; and as flour, it is used in breads and many other baked products.

Of the cereal flours, only wheat and rye can be used successfully in production of leavened bread. Rye is considered inferior to wheat in production of high-volume pan breads, because its dough lacks essential

elasticity and gas-retention properties. Rye flour can be used alone to produce "black" bread, which is consumed extensively in eastern Europe and parts of Asia. In many countries, "light-rye" breads are made from rye and wheat flours mixed in varying proportions. The characteristic flavor of rye is liked by many people. Small quantities of rye are used in production of baked specialty products, such as flat breads and rye crisps.

Although used extensively as livestock feed, rye grain has a relatively low feed value compared with other feed grains. It tends to form a sticky mass in an animal's mouth and can be extremely unpalatable and even toxic if ergot is present. Rye is generally used in small proportions in mixtures with other grains. On occasion, the price of rye makes it an attractive feed grain despite its low feed value. Recent improvements in animal feed production technology, especially in the use of various enzymes to improve palatability, has led to a substantial increase in the proportion of rye grain that can be included in mixed animal feeds.

Substantial quantities of rye grain are also used in production of alcoholic beverages. Rye is the acknowledged trademark of Canadian whiskey.

In the growth stage before heading, rye is used extensively as a pasture crop. It can be pastured during both autumn and spring or only during the autumn and then cropped in the spring. Occasionally, it is grazed during the autumn and then used as a spring cover crop or plowed under as green manure for another crop of higher economic value.

Rye straw is fibrous and tough and, therefore, is not used extensively in livestock feed. It is highly desirable, however, for use as livestock bedding. Small quantities of rye straw are also used in the manufacture of strawboard and paper.

In spite of its deficiencies, rye should continue to be an important crop because it has some significant advantages over other crops. As mentioned above, the rye plant is considerably more winter hardy than wheat and produces economical yields on poor, sandy soils where no other useful crop can grow. It is grown in many areas that have no alternative crop and is a good rotational crop because of its ability to compete effectively with weeds. In some countries, it is used as a pioneer crop to improve the fertility of wasteland

and sterile soils. In Argentina, it is an important pasture crop, and in southern Australia, it is planted to prevent wind erosion. It is also grown in other countries where rye bread is popular with local consumers. Its many uses and advantages far outweigh its deficiencies.

## International Trade

World trade in rye grain dropped sharply during the early 1960s, but fluctuations have been relatively small since 1964 (Tables III and IV). In 1996, of the total world production, only 13% was exported. More than 20% of the world production of wheat (about 550 million metric tons) was exported. Domestic consumption of rye is greatest in countries where the crop traditionally has been grown. Only one major nonproducing country, Japan, has become an important consumer of rye.

The major exporters (Table III) during the 1990s were Germany, three republics of the former Soviet Union, and Canada. The United States and Sweden are no longer significant exporters. Exports from a specific country can fluctuate widely from zero during years with low production and domestic shortages of food and feed grains to maximum quantities during years with high production and high international demand.

Since the 1970s, Japan has gradually become the largest importer of rye (Table IV). Much of its imported rye is used for animal feed, but because rye bread is becoming increasingly popular in Japan, sub-

**Table II. Rye and Wheat Production (1,000 metric tons) by Country, 1995<sup>a</sup>**

Country	Rye	Wheat
Poland	6,288	8,668
Germany	4,533	17,816
Russian Federation	4,098	30,118
Belarus	2,150	360
Ukraine	1,280	16,273
China	600	102,211
Denmark	518	4,420
Austria	314	1,301
Lithuania	300	750
Canada	294	25,432
Czech Republic	262	3,823
United States	252	59,494
Turkey	240	18,015
World	22,610	541,120

<sup>a</sup> FAO (4).

**Table I. World Production (1,000 metric tons) of Cereal Crops, 1987–1996<sup>a</sup>**

Crop	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Wheat	495,968	495,034	533,168	588,007	542,132	561,807	559,276	524,798	536,877	579,062
Maize	451,085	400,647	460,936	482,494	491,456	538,575	475,494	559,579	513,078	571,174
Rice <sup>b</sup>	314,670	331,523	343,632	352,181	354,830	355,481	355,557	365,602	370,406	378,654
Barley	173,900	162,823	164,857	178,056	169,144	165,767	169,962	160,586	141,638	154,629
Sorghum	56,387	54,477	55,262	53,694	53,636	65,387	56,680	57,891	54,508	65,892
Oat	40,641	35,430	39,272	39,063	32,820	33,609	35,454	33,139	28,690	31,650
Millet	25,011	31,115	29,159	28,022	24,766	29,567	25,605	27,293	24,877	28,170
Rye	30,988	29,628	33,345	36,861	27,358	28,658	26,088	21,883	21,939	21,982

<sup>a</sup> USDA-FAS (11).

<sup>b</sup> Milled.

stantial quantities now go to the baking industry as well. Other importers of significant quantities of rye include the United States, China, Spain, the Czech Republic, Poland,

and Germany. All of these, except Spain, are also major producers of rye. Most of these countries are highly dependent on the crop for bread production, and this need cannot

be easily filled by wheat because of traditional food preferences and other economic reasons. During years with exceptionally good yields, rye production in these countries meets domestic requirements. Accordingly, imports fluctuate markedly from year to year. For example, imports by Germany from 1987 to 1996 ranged from a high of 193,000 metric tons in 1987 to zero from 1991 to 1996. Poland, which normally imports 50,000–100,000 metric tons per year, did not import any in some years but purchased 524,000 metric tons in 1992. International trade in rye, therefore, is highly volatile, depending primarily on domestic production in the major consuming countries.

The price of rye fluctuated widely during the 1980s and 1990s and generally followed the price of feed wheat and barley (Fig. 1). Price fluctuations in any one year

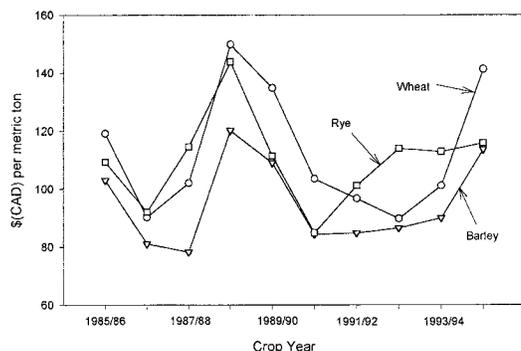


Fig. 1. Average annual prices of rye, feed barley, and feed wheat in Winnipeg, Canada (2).

Table III. Major Exporters of Rye (1,000 metric tons), 1987–1996<sup>a</sup>

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Europe										
Belgium	5	1	1	1	2	1	0	0	0	0
Czech Republic	0	0	0	1	20	20	9	5	5	0
Denmark	333	107	191	67	125	510	171	40	100	50
France	22	32	39	24	53	15	9	15	20	20
Germany <sup>b</sup>	280	140	55	218	515	1,408	578	2,075	2,300	2,100
Netherlands	11	5	7	4	6	6	10	10	5	5
Poland	20	50	100	44	644	32	10	0	100	0
Sweden	17	20	83	83	49	10	43	30	20	25
Former Soviet Union										
Belarus	350	350	400	300	200	250	100	25	25	125
Russia	300	300	300	350	150	200	210	278	100	200
Ukraine	0	0	0	0	0	0	0	50	25	125
North America										
Canada	178	115	293	349	225	196	152	175	110	175
United States	13	86	20	5	1	0	0	1	1	1
World	1,706	1,316	1,590	1,552	2,103	2,728	1,430	2,856	3,006	2,896

<sup>a</sup> USDA-FAS (11).

<sup>b</sup> Sum of exports from the Federal Republic of Germany and the German Democratic Republic, 1987–1990.

Table IV. Major Importers of Rye (1,000 metric tons), 1987–1996<sup>a</sup>

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
North America										
United States	31	5	1	99	115	79	117	111	96	102
Asia										
China	...	0	0	0	0	0	0	731	100	50
Japan	340	185	258	314	401	350	400	435	475	425
Europe										
Finland	46	51	7	1	0	7	8	0	12	0
Germany	...	...	...	...	13	21	23	80	20	25
Federal Republic of Germany	183	78	59	23	...	...	...	...	...	...
German Democratic Republic	10	40	10	...	...	...	...	...	...	...
Netherlands	50	45	28	29	38	37	30	30	30	30
Spain	0	0	2	0	0	0	0	150	200	100
Sweden	75	50	5	0	0	0	0	0	0	0
United Kingdom	28	18	13	12	10	5	12	25	20	20
Norway	28	33	85	30	30	21	40	50	50	50
Czechoslovakia	25	54	50	50	10	...	...	...	...	...
Czech Republic	...	...	...	...	...	0	25	0	0	150
Poland	19	85	100	0	0	524	22	17	0	125
Russia	150	200	50	100	390	675	0	0	100	100
Estonia	20	45	75	30	50	50	50	20	25	20
Latvia	50	50	50	50	50	50	50	50	50	50
Lithuania	30	20	20	50	20	50	50	50	50	0
World	1,718	1,440	1,641	1,554	2,020	2,610	1,149	2,839	2,451	2,088

<sup>a</sup> USDA-FAS (11).

depend on short-term supply and demand. Generally, rye is priced substantially below milling wheat on the international market. On occasion, however, scarcity has brought rye prices close to those of wheat. During times when production exceeds demand and the price of rye is below the price of barley, considerable quantities of rye are used in animal feed.

Rye from exporting countries varies considerably in price and quality. From any one source, price differences for cultivars or grades of rye are relatively small. The price spread between rye grain, flour, and bread is considerably smaller than the equivalent spread for wheat. Rye bread prices in the major consuming countries are always lower than wheat bread prices, and rye bread is generally a staple food for low-income people. In many countries where bread is baked from a mixture of rye and wheat flours, a low-grade wheat flour is used (e.g., first clear in North America), which further lowers the price of rye bread compared with that of traditional wheat bread.

Although rye is inferior in several ways to the predominant cereal crops (wheat, rice, and maize), it will continue to be an important crop for farmers in many countries because of its winter hardiness and ability to grow in poor soils and because of consumer demand for baked products with the unique flavor of rye.

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