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U. S. DEPARTMENT OF AGRICULTURE.

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OATS: DISTRIBUTION AND USES.

BY

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LETTER OF TRANSMITTAL

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., August 20, 1910.

SIR: I have the honor to transmit and to recommend for publication as a Farmers' Bulletin the accompanying manuscript, entitled "Oats: Distribution and Uses," prepared by Mr. C. W. Warburton, Agronomist in Charge of Oat Investigations, under the direction of Mr. M. A. Carleton, Cerealist in Charge of Grain Investigations.

Statistical figures of the production and value of the oat crop are given, the market grades are described, and the uses and composition of the grain, straw, and other products of the plant are discussed. The publications of the state agricultural experiment stations and of other bureaus of this Department have been freely used in the preparation of this manuscript, which is supplementary to Farmers' Bulletin 424, entitled "Oats: Growing the Crop." It is believed that the information here presented will be of general interest and value to farmers.

Respectfully,

G. H. POWELL,
Acting Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

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OATS: DISTRIBUTION AND USES.

INTRODUCTION.

The utilization of a crop and its by-products to secure the best returns presents problems almost equal in importance to those involved in its economical and profitable production. The grower should be familiar with the production and value of the crop in other sections and in other countries, with the grades into which it is usually classified on the market, and with the uses which can be made of it. In the case of a grain crop largely used for feeding to farm animals, he should know its nutritive value as compared with similar crops, as well as the digestibility of the matter contained in the grain and other products. The object of this bulletin is to supply information along these lines regarding oats. The methods of growing and harvesting this crop are discussed in another publication of this series.^a

PRODUCTION AND DISTRIBUTION OF THE OAT CROP.

WORLD PRODUCTION OF OATS.

The production of oats is practically confined to the Temperate Zones. The crop does best in cool, moist climates and will not thrive in the warmer regions unless the water supply is ample. It reaches its best development in Norway, Sweden, Germany, Great Britain, and Canada, and in the United States in Washington, Idaho, and Montana. Good spring oats are seldom produced in the southern part of the United States or in southern Europe, while the northern limit of production is near the Arctic Circle, in Norway and Alaska. The crop is very generally grown in the central and northern portions of the North Temperate Zone.

^a Oats: Growing the Crop. Farmers' Bulletin 424, U. S. Dept. of Agriculture, 1910. Other publications relating to oats which may be obtained free upon request to the Secretary of Agriculture, Washington, D. C., are: The Prevention of Stinking Smut of Wheat and Loose Smut of Oats, Farmers' Bulletin 250, U. S. Dept. of Agriculture, 1906; Sixty-Day and Kherson Oats, Farmers' Bulletin 395, U. S. Dept. of Agriculture, 1910; and Improvement of the Oat Crop, Circular 30, Bureau of Plant Industry, 1909.

The world production of oats in bushels is greater than that of either corn or wheat, but as its weight per bushel is much less, the total production in pounds is smaller than that of either of those crops. The average annual world production of oats for the five years 1905-1909 was 3,694,702,000 bushels (see Table I); of corn, 3,443,169,000 bushels; and of wheat, 3,336,789,000 bushels. The actual world production of all these crops, particularly of oats and wheat, is considerably larger than these figures show, no statistics being available for South America and for a large part of both Asia and Africa. The production of oats in Africa is small, but in South America and in some portions of Asia for which no figures are published it is considerable. The 1909 crop of the world was about one-fifth larger than that of any of the previous four years, reaching a total of 4,295,865,000 bushels. For the five years the average European production of oats was 2,393,705,000 bushels, or practically two-thirds of the crop of the world. Russia, Germany, France, and Austria-Hungary are the leading European countries in the production of oats, as shown in Table II. North America produced 1,172,124,000 bushels, nearly four-fifths of which were produced in the United States.

TABLE I.—*Annual and average world production of oats, by continents, for the five years 1905-1909.*^a

Continent.	1905.	1906.	1907.	1908.	1909.	Average.
	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
North America....	1,195,761,000	1,225,056,000	983,677,000	1,073,199,000	1,382,928,000	1,172,124,000
Europe.....	2,192,855,000	2,188,632,000	2,466,795,000	2,338,312,000	2,781,932,000	2,393,705,000
Asia.....	85,898,000	80,072,000	85,507,000	107,308,000	78,105,000	87,278,000
Africa.....	12,077,000	14,797,000	16,805,000	12,838,000	16,743,000	14,652,000
Australasia.....	24,076,000	23,913,000	25,596,000	24,970,000	36,157,000	26,943,000
Total.....	3,510,167,000	3,532,470,000	3,578,380,000	3,556,627,000	4,295,865,000	3,694,702,000

^a This table and those which follow have been compiled from publications of the Bureau of Statistics, U. S. Dept. of Agriculture.

TABLE II.—*Leading countries of the world in the production of oats, with their annual and average production for the five years 1905-1909.*

Country.	1905.	1906.	1907.	1908.	1909.	Average.
	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
United States.....	953,216,000	964,905,000	754,443,000	807,156,000	1,007,353,000	897,415,000
European Russia.....	851,667,000	633,291,000	822,084,000	834,518,000	1,067,668,000	841,846,000
Germany.....	451,017,000	680,875,000	630,324,000	530,131,000	623,718,000	564,213,000
France.....	269,581,000	256,943,000	303,889,000	285,837,000	339,743,000	291,199,000
Canada.....	242,523,000	260,134,000	229,217,000	266,026,000	375,558,000	274,695,000
Austria-Hungary.....	210,899,000	251,363,000	256,838,000	222,062,000	274,392,000	243,112,000
United Kingdom.....	171,527,000	180,384,000	189,478,000	181,555,000	184,523,000	181,494,000
Asiatic Russia.....	84,995,000	79,713,000	85,176,000	106,898,000	77,705,000	86,897,000
Sweden.....	58,488,000	64,550,000	64,597,000	72,773,000	69,292,000	65,940,000

PRODUCTION OF OATS IN THE UNITED STATES.

The oat crop ranks fifth in value among the farm crops of the United States, being exceeded by corn, cotton, wheat, and hay. It is third among the cereals, being exceeded only by corn and wheat. The acreage devoted to oats is slightly larger than the cotton acreage and is much smaller than that of the other crops mentioned. The 1909 oat crop, slightly over 1,000,000,000 bushels, was about 275,000,000 bushels larger than the wheat crop of that year, but the value was only \$408,000,000, as compared with \$730,000,000 for wheat. The corn crop of 1909 was valued at \$1,650,000,000, or more than four times as much as the oat crop. The farm value of all cereals for 1909 was estimated at \$3,000,000,000, of which amount the oat crop represented about 13 per cent.

The average production of oats in the United States for the ten years from 1900 to 1909 was 869,954,000 bushels, produced on 29,643,000 acres. The corn crop for the same period was 2,453,169,000 bushels, grown on 95,028,000 acres, and the wheat crop 659,509,000 bushels, produced on 46,678,000 acres.

The rapid increase in the production of oats since 1870 is shown in Table III. The crop of 1909 was the largest yet grown, both in area, 33,204,000 acres, and in yield, 1,007,353,000 bushels. These figures are more than three times the annual acreage and production of oats from 1870 to 1879. According to a recent estimate, 1.6 per cent of the total land area of the United States was devoted to oats during the ten years 1900-1909, as compared with 1.2 per cent during the ten years preceding, and 2.5 and 5 per cent devoted to wheat and corn, respectively.

TABLE III.—*Acreage, production, and value of oats in the United States, by ten-year periods, from 1870 to 1909.*

Period.	Acreage sown and harvested.	Mean yield per acre.	Production.	Mean farm price per bushel, December 1.	Farm value, December 1.
	<i>Acres.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Cents.</i>	
1870-1879.....	11, 076, 822	28. 4	314, 441, 178	33. 7	\$103, 206, 496
1880-1889.....	21, 996, 375	26. 5	584, 395, 839	32. 0	180, 866, 412
1890-1899.....	26, 666, 691	26. 2	698, 158, 388	27. 8	189, 469, 553
1900-1909.....	29, 643, 072	29. 5	869, 953, 989	35. 5	306, 072, 806

The average acreage and production and the mean yield per acre of oats for the United States for the ten-year period 1900-1909 are shown in Table IV. The States are arranged according to their rank in production. The mean farm value per bushel and per acre on December 1 and the average annual farm value are also shown in this table. More than half of the total crop for this period, or

446,165,000 bushels annually, was produced in the five leading States—Illinois, Iowa, Wisconsin, Minnesota, and Nebraska.

TABLE IV.—*Acreage, production, and value of the oat crop in the United States for the ten years 1900–1909, the States arranged according to their rank in production.^a*

Rank.	State.	Acreage.	Mean yield per acre.	Production.	Mean farm price per bushel, December 1.	Total farm value, December 1.	Mean value per acre, December 1.
		<i>Acres.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Cents.</i>		
1	Illinois	3,893,790	31.2	121,107,519	33.8	\$40,248,459	\$10.26
2	Iowa	4,059,200	29.5	119,140,838	30.1	35,418,873	8.66
3	Wisconsin	2,847,416	33.3	78,487,509	34.5	26,493,005	11.24
4	Minnesota	2,243,815	31.7	70,784,831	31.1	21,859,728	9.62
5	Nebraska	2,128,488	26.4	55,644,291	30.1	16,608,106	7.73
6	Indiana	1,504,744	29.0	43,012,800	33.8	14,368,780	9.49
7	Ohio	1,285,602	33.2	42,007,577	36.4	15,215,982	11.79
8	New York	1,906,944	31.3	40,797,664	43.4	17,374,513	13.44
9	Michigan	1,161,260	31.6	35,994,019	37.0	13,327,118	11.41
10	Pennsylvania	1,141,057	29.3	33,525,321	41.7	13,568,694	12.03
11	North Dakota	1,044,031	29.7	31,392,559	31.2	9,666,039	8.98
12	South Dakota	951,558	31.6	29,353,752	30.3	9,003,065	9.33
13	Kansas	1,013,902	24.4	24,856,354	34.8	8,281,639	8.23
14	Texas	798,442	27.8	22,712,103	48.2	10,242,235	12.71
15	Missouri	759,245	23.4	17,714,308	35.2	5,963,903	7.98
16	Oklahoma ^b	480,303	29.4	13,872,995	37.7	5,202,283	10.58
17	Oregon	273,214	30.0	8,316,130	43.7	3,663,797	13.18
18	Montana	187,164	43.3	8,286,963	41.9	3,521,286	18.14
19	Washington	163,667	46.3	7,693,716	42.8	3,330,028	19.86
20	Colorado	146,059	35.3	5,208,991	47.4	2,501,761	16.76
21	Kentucky	239,696	21.0	5,053,044	41.6	2,000,321	8.60
22	California	159,061	31.2	5,088,567	55.9	2,877,245	17.61
23	Georgia	291,986	15.3	4,500,511	60.3	2,755,622	9.33
24	Maine	118,952	37.1	4,402,672	48.8	2,136,252	18.00
25	Arkansas	215,173	20.0	4,278,423	47.0	1,948,183	9.34
26	Idaho	99,871	41.7	4,242,563	45.1	1,940,498	18.82
27	Virginia	209,237	17.6	3,598,184	44.8	1,603,720	7.93
28	Tennessee	188,094	19.4	3,568,663	43.7	1,557,242	8.54
29	South Carolina	209,212	17.1	3,564,592	61.9	2,226,572	10.75
30	Alabama	225,032	15.6	3,509,503	57.6	2,038,473	9.05
31	North Carolina	226,458	14.8	3,325,908	53.6	1,767,868	8.00
32	Vermont	81,456	36.0	2,929,547	47.5	1,370,036	16.97
33	West Virginia	94,735	22.1	2,082,669	45.1	926,602	9.91
34	Mississippi	116,685	16.7	1,914,119	56.2	1,081,705	9.38
35	New Jersey	66,699	28.0	1,862,924	43.6	792,514	12.13
36	Utah	46,642	40.3	1,835,042	47.5	877,053	19.13
37	Wyoming	50,153	35.9	1,804,042	46.8	854,105	16.77
38	Maryland	38,778	25.1	961,902	41.1	381,427	10.32
39	Louisiana	31,042	16.9	523,677	51.2	268,463	8.65
40	New Hampshire	14,346	32.3	464,032	50.0	225,391	16.10
41	New Mexico	14,951	29.9	460,160	59.0	278,489	17.57
42	Florida	31,196	13.5	421,248	64.5	273,872	8.82
43	Connecticut	11,156	31.9	354,863	47.4	164,526	15.05
44	Massachusetts	7,643	33.1	252,495	49.9	122,532	16.45
45	Nevada ^c	6,416	38.2	248,502	63.3	160,939	24.28
46	Delaware	5,654	25.3	134,244	42.8	54,693	10.96
47	Arizona ^c	2,243	33.0	75,633	68.1	52,633	22.52
48	Rhode Island	1,954	29.4	57,745	50.7	28,230	14.58
	United States ^d	29,643,072	29.5	869,953,989	35.5	306,072,805	10.26

^a The mean yield per acre, price per bushel, and value per acre in this table are averages of the annual figures rather than computations from the average acreage, production, and farm value for the ten-year period.

^b The Oklahoma figures are for nine years, 1901–1909, and include Indian Territory previous to the admission of the State.

^c The Nevada and Arizona figures are for nine years.

^d Does not include estimates for Indian Territory, Nevada, and Arizona for the year 1900.

The five States leading in the production of oats for the ten-year period 1900–1909 were Illinois, Iowa, Wisconsin, Minnesota, and Nebraska. The diagram (fig. 1) shows the proportion of the total crop of the United States grown in each of the States producing more than 10,000,000 bushels. The sixteen States shown on this dia-

gram grew nearly 90 per cent of the total crop. Illinois and Iowa each produced nearly 14 per cent, while approximately 9, 8, and 6 per cent were produced in Wisconsin, Minnesota, and Nebraska, respectively.

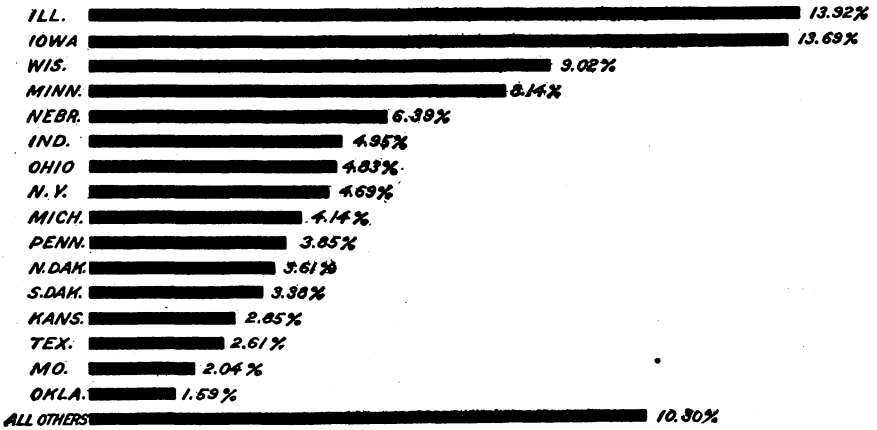


FIG. 1.—Diagram showing the proportion of the total oat crops of the United States for the ten years 1900-1909 produced by the different States.

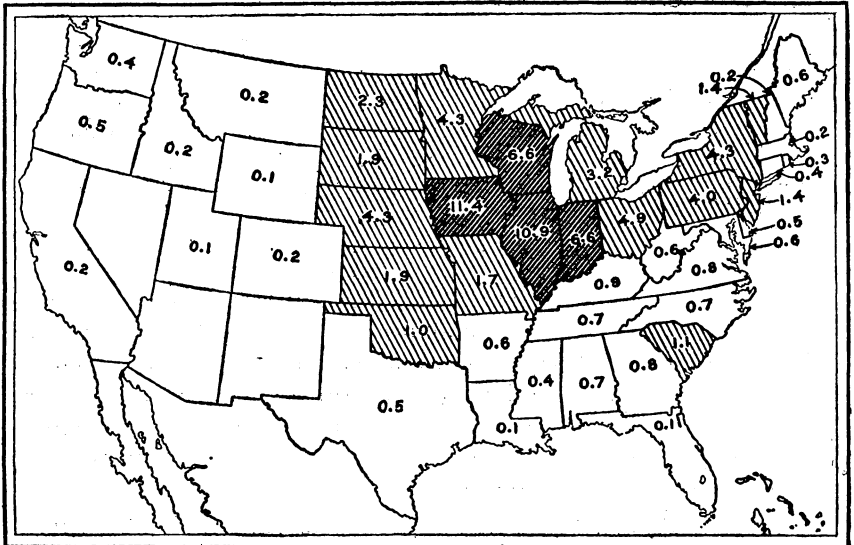


FIG. 2.—Map of the United States, showing the percentage of the total acreage of each State devoted to oats for the ten years 1900-1909. In the unshaded portion less than 1 per cent of the area is devoted to this crop; in the lightly shaded portion, from 1 to 5 per cent; and in the heavily shaded portion, more than 5 per cent. Where no figures are given, less than one-tenth of 1 per cent is devoted to oats.

spectively. In acreage devoted to oats Iowa slightly exceeds Illinois. Wisconsin, Minnesota, and Nebraska follow in the order named. Figure 2 shows the percentage of the total area of each State annu-

ally devoted to oats in the ten years 1900–1909. In Iowa the crop was grown on 11.4 per cent of the area and in Illinois on 10.9 per cent. Only two other States, Indiana and Wisconsin, devoted more than 5 per cent of their area to oats. As previously stated, 1.6 per cent of the total acreage of the United States was annually devoted to oats during this period. In Maine, Vermont, New York, Wisconsin, Montana, and Wyoming the acreage devoted to oats exceeds the combined acreage of both wheat and corn. It exceeds the wheat acreage in the other New England States and in Florida, Alabama, Mississippi, Louisiana, Michigan, Illinois, and Iowa, but is exceeded by the corn acreage in these States. The acreage in oats exceeds that devoted to corn in Minnesota and North Dakota and in all of the Rocky Moun-

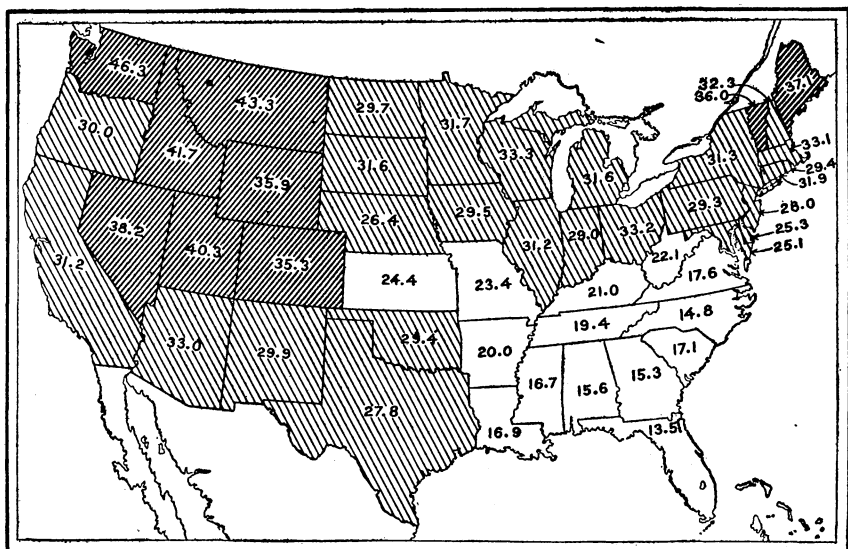


FIG. 3.—Map of the United States, showing the mean yield of oats, in bushels per acre, for the ten years 1900–1909. In the unshaded portion the mean yield is less than 25 bushels; in the lightly shaded portion, from 25 to 35 bushels; and in the heavily shaded portion, more than 35 bushels.

tain and Pacific Coast States, but it is exceeded by the wheat acreage. The corn acreage exceeds that in oats in Arizona and New Mexico.

Illinois, Iowa, Wisconsin, and Minnesota rank in the order named in the total annual value of their oat crops. New York, on account of the high price per bushel, 43.4 cents, ranks fifth, though exceeded in production by Nebraska, Indiana, and Ohio. Washington, Montana, Idaho, Utah, and Nevada show the highest yield to the acre. In all of these States most of the oat crop is grown under irrigation. Maine, Vermont, Wisconsin, and Minnesota are among the States which show the highest yield without irrigation. In general, the highest yields are found in the Northern and Western States and the lowest in the Southeastern States, as shown in figure 3.

The highest price per bushel and the highest acre value are found in Arizona and Nevada, respectively. In these States practically the entire oat crop is grown under irrigation, so that the cost of production is high. The annual crop in Nevada is only about 250,000 bushels, while Arizona produces less than 100,000 bushels. The acre value in Nevada is \$24.28, while in Arizona it is \$22.52. The leader in acre value among the important States in oat production is Washington, with \$19.86, followed closely by Utah, Idaho, and Montana. Owing to the high cost of producing the crop under irrigation in these States, however, the net profit to the acre is probably not greater than in some of the States where the acre value is much lower. The acre value of the oat crop in each of the States is shown

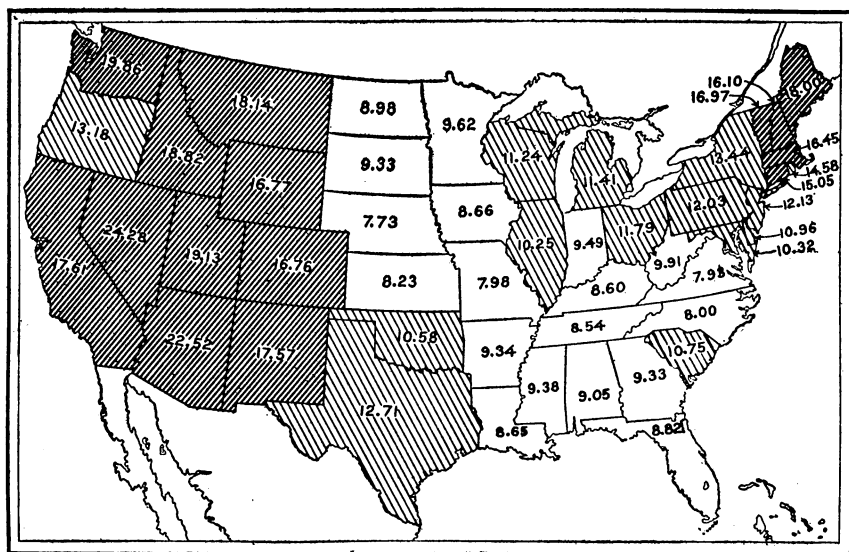


FIG. 4.—Map of the United States, showing the mean acre value of oats on December 1 for the ten years 1900-1909. In the unshaded portion the mean value is less than \$10 to the acre; in the lightly shaded portion, from \$10 to \$15; and in the heavily shaded portion, more than \$15.

in figure 4. The highest acre values are found in the New England, Rocky Mountain, and Pacific Coast States. The highest price per bushel is ordinarily found in the South, the low acre value being due to the low yield. In the Central States west of the Mississippi River, where the yield is comparatively high, the low price per bushel is the cause of the low acre value.

MARKETING OATS.

HOME CONSUMPTION.

The greater portion of the oat crop of the United States is fed on the farms where it is grown. According to the figures of the Bureau of Statistics of this Department, in the ten years from 1900 to 1909

28.7 per cent of the crop was shipped out of the county where it was grown. The average annual shipment for the ten years was 246,000,000 bushels. The smallest proportion of the crop shipped out of the county where grown was of the small crop of 1901, 19.5 per cent, and the largest proportion was of the crop of 1909, the largest crop on record, 32.7 per cent. The largest shipment of any one crop was of that of 1909, nearly 330,000,000 bushels.

PREPARATION FOR MARKET.

The grade of oats can often be raised by running the grain through a fanning mill, removing the dirt, trash, weed seeds, and light oats. Little attention is paid to the matter of dirt in market oats, however, either at country elevators or at the central markets, so that at present the farmer is hardly justified in cleaning his grain before marketing. Oats are occasionally clipped to increase the weight per bushel and the market price. By this process a portion of the hull is removed from the tip of the grain, but as special machinery is required it is little used except in elevators. Bleaching with sulphur fumes or other chemical means is sometimes used in elevators to improve the appearance of oats. By this process grain which has been discolored from weathering or from heating in stack or bin is rendered bright and white in appearance. While it is probable that the bleaching process causes little damage to the feeding value of the grain, its germination is often materially lowered, and bleached or purified grain should never be bought for seed without a satisfactory germination test. As weathering or heating usually diminishes the feeding value of grain, chemically purified grain is ordinarily somewhat lower in that respect than its appearance indicates.

LEGAL WEIGHT.

The legal weight of a bushel of oats is 32 pounds in most of the States. In Maryland it is 26 pounds, while in Virginia and New Jersey it is 30 pounds. The Baltimore Chamber of Commerce and the Richmond Grain and Cotton Exchange, however, use 32 pounds as the weight of a bushel of oats. In Idaho 36 pounds is the standard. No legal weight is fixed in Delaware, Nevada, New Mexico, South Carolina, Utah, and Wyoming. In Canada 34 pounds is the legal weight of a bushel of oats.

MARKET GRADES.

The market grades of oats differ somewhat in the different grain centers of the country, so no universal standard can be given. The following grades have been adopted by the Grain Dealers' National Association.^a They are not recommended for general use by the De-

^a Grades of grain adopted by the Grain Dealers' National Association at the thirteenth annual convention, held at Indianapolis, Ind., October 6-8, 1909.

partment of Agriculture, but are presented as a matter of general interest to farmers, who are often not familiar with the market grades of grain.

WHITE OATS.

No. 1 white oats shall be white, dry, sweet, sound, bright, clean, free from other grain, and weigh not less than 32 pounds to the measured bushel.

No. 2 white oats shall be 95 per cent white, dry, sweet, shall contain not more than 1 per cent of dirt and 1 per cent of other grain, and weigh not less than 29 pounds to the measured bushel.

Standard white oats shall be 92 per cent white, dry, sweet, shall not contain more than 2 per cent of dirt and 2 per cent of other grain, and weigh not less than 28 pounds to the measured bushel.

No. 3 white oats shall be sweet, 90 per cent white, shall not contain more than 3 per cent of dirt and 5 per cent of other grain, and weigh not less than 24 pounds to the measured bushel.

No. 4 white oats shall be 90 per cent white, may be damp, damaged, musty, or very dirty.

NOTICE.—Yellow oats shall not be graded better than No. 3 white oats.

MIXED OATS.

No. 1 mixed oats shall be oats of various colors, dry, sweet, sound, bright, clean, free from other grain, and weigh not less than 32 pounds to the measured bushel.

No. 2 mixed oats shall be oats of various colors, dry, sweet, shall not contain more than 2 per cent of dirt and 2 per cent of other grain, and weigh not less than 28 pounds to the measured bushel.

No. 3 mixed oats shall be sweet oats of various colors, shall not contain more than 3 per cent of dirt and 5 per cent of other grain, and weigh not less than 24 pounds to the measured bushel.

No. 4 mixed oats shall be oats of various colors, damp, damaged, musty, or very dirty.

RED OR RUSTPROOF OATS.

No. 1 red oats, or rustproof, shall be pure red, sound, bright, sweet, clean, and free from other grain, and weigh not less than 32 pounds to the measured bushel.

No. 2 red oats, or rustproof, shall be seven-eighths red, sweet, dry, and shall not contain more than 2 per cent dirt or foreign matter, and weigh 30 pounds to the measured bushel.

No. 3 red oats, or rustproof, shall be sweet, seven-eighths red, shall not contain more than 5 per cent dirt or foreign matter, and weigh not less than 24 pounds to the measured bushel.

No. 4 red oats, or rustproof, shall be seven-eighths red, may be damp, musty, or very dirty.

WHITE CLIPPED OATS.

No. 1 white clipped oats shall be white, clean, dry, sweet, sound, bright, free from other grain, and weigh not less than 35 pounds to the measured bushel.

No. 2 white clipped oats shall be 95 per cent white, dry, sweet, shall not contain more than 2 per cent of dirt or foreign matter, and weigh not less than 32 pounds to the measured bushel.

No. 3 white clipped oats shall be sweet, 90 per cent white, shall not contain more than 5 per cent of dirt or foreign matter, and weigh not less than 30 pounds to the measured bushel.

No. 4 white clipped oats shall be 90 per cent white, damp, damaged, musty, or dirty, and weigh not less than 30 pounds to the measured bushel.

MIXED CLIPPED OATS.

No. 1 mixed clipped oats shall be oats of various colors, dry, sweet, sound, bright, clean, free from other grain, and weigh not less than 35 pounds to the measured bushel.

No. 2 mixed clipped oats shall be oats of various colors, dry, sweet, shall not contain more than 2 per cent of dirt or foreign matter, and weigh not less than 32 pounds to the measured bushel.

No. 3 mixed clipped oats shall be sweet oats of various colors, shall not contain more than 5 per cent of dirt or foreign matter, and weigh not less than 30 pounds to the measured bushel.

No. 4 mixed clipped oats shall be oats of various colors, damp, damaged, musty, or dirty, and weigh not less than 30 pounds to the measured bushel.

NOTE.—Inspectors are authorized when requested by shippers to give weight per bushel instead of grade on clipped white oats and clipped mixed oats from private elevators.

PURIFIED OATS.

All oats that have been chemically treated or purified shall be classed as purified oats, and inspectors shall give the test weight on each car or parcel that may be so inspected.

EXPORTS AND IMPORTS.

In the ten years ended June 30, 1909, the average yearly export shipment of oats, including oatmeal, from the United States was slightly less than 18,000,000 bushels annually, or about 2 per cent of the crop. The largest single year's shipment during this period was made in the fiscal year ended June 30, 1906, when more than 48,000,000 bushels were exported, while the smallest exportation, less than 2,000,000 bushels, was made in 1904. The average yearly importation of oats, including oatmeal, during the ten-year period was 772,184 bushels. By far the greater portion of the imports in this decade was received in the fiscal year 1909, when 6,691,703 bushels were imported, practically three times the quantity recorded in any previous year since 1865. The next largest importation in the decade, 383,418 bushels, was recorded in the fiscal year ended June 30, 1908. The importation of oats is largely confined to grain to be used for seed or, in years of short crops of poor quality, for milling.

COMPOSITION OF OATS.

The proportion of grain to straw in the oat plant, the proportion of kernel to hull in the grain, and the chemical composition and digestibility of the grain, straw, and hay will now be discussed.

PROPORTION OF GRAIN TO STRAW.

The proportion of grain to straw varies widely in different varieties of oats, in different seasons, and under different conditions of

growth. Twenty-five varieties of oats in a five-year test at the Ohio Agricultural Experiment Station averaged 44.4 pounds of straw to 1 bushel of grain, or slightly more than $1\frac{1}{3}$ pounds of straw to 1 pound of grain. The individual varieties varied from a little more than 1 to almost 2 pounds of straw to 1 pound of grain. In a publication of this station another average in seven years of 1 pound of grain to 2 pounds of straw is reported.

In Illinois variations from 1.2 pounds to 2.7 pounds of straw to 1 pound of grain are reported in different seasons. The Kansas Agricultural Experiment Station reports a still greater variation of 1.2 to 4.1 pounds of straw to 1 pound of grain in different seasons. Under irrigation the usual proportion is about 1 pound of grain to 2 pounds of straw.

PROPORTION OF KERNEL TO HULL.

Like the proportion of grain to straw, the proportion of kernel to hull is decidedly variable. Not only is there a great difference in varieties in this respect, but seasonal and soil conditions also have a marked influence. There is no fixed relation between the weight per bushel and the proportion of kernel to hull, though with a given variety greater weight per bushel is usually associated with a greater proportion of kernel to hull. Oats ordinarily contain from 65 to 70 per cent of kernel. In very poor samples, however, the kernel may constitute not more than 55 per cent of the grain, and in very good ones it may make up 75 to 80 per cent. The varieties with long, slender grains usually contain a higher proportion of kernel than those with short, thick grains. Small, early varieties, like the Sixty-Day and the Kherson, usually contain a very high percentage of kernel. The Swedish Select, a popular variety in the Northern States, also makes an excellent showing in this respect.

Seasonal variation in the proportion of kernel to hull is well shown in some determinations made by the writer. Samples of seven varieties grown at the Wisconsin station in 1905 averaged 71.97 per cent of kernel, while the same varieties in 1907, a much poorer year for the production of oats, contained but 66.62 per cent. The varieties ranged from 69.13 to 78.07 per cent in 1905, and from 63.71 to 69.86 per cent in 1907, the variety with the lowest percentage in 1905 being highest in 1907. Six varieties of oats grown under irrigation at the Montana station in 1906 averaged 75.79 per cent of kernel, while the following year they averaged 71.81 per cent, though the difference in the average weight per bushel was less than 1 pound in the two years.

CHEMICAL ANALYSES.

The chemical composition of oats, oat straw, oat hay, and the green plant, together with similar analyses of other grains for comparison, is shown in Table V.

TABLE V.—Results of analyses of oats and of oat products, showing the percentage of water and the number of pounds of ash, protein, etc., in 100 pounds of water-free substance, with similar figures for other grains for comparison.^a

Feed.	Samples.	Water.	Constituents in 100 pounds of dry matter.				
			Ash.	Protein.	Fiber.	Carbohydrates.	Fat.
Grain:	<i>Number.</i>	<i>Per cent.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Oats	30	11.0	3.3	13.3	10.7	67.1	5.6
Wheat	310	10.5	2.0	13.4	2.0	80.3	2.3
Barley	10	10.9	2.7	14.0	3.0	78.8	2.0
Corn	208	10.9	1.7	11.8	2.3	78.1	6.1
Oat products:							
Oat shorts	2	5.4	3.8	19.1	5.7	65.4	6.0
Oat bran	2	6.1	6.7	13.0	19.8	56.3	4.2
Oat dust	2	6.5	7.4	14.4	19.5	53.6	5.1
Oat kernels	6	7.9	2.2	16.0	1.0	73.1	7.7
Oat hulls	1	7.3	7.2	3.6	32.0	56.1	1.1
Straw:							
Oat straw	12	9.2	5.6	4.4	40.8	46.7	2.5
Wheat straw	7	9.6	4.7	3.8	42.1	48.0	1.4
Barley straw	97	14.7	6.7	4.1	42.0	45.5	1.7
Rye straw	7	7.1	3.4	3.2	41.9	50.2	1.3
Corn stover	60	40.5	5.7	6.4	33.1	53.0	1.8
Hay:							
Oat hay	12	16.0	7.3	8.8	32.4	48.3	3.2
Oat and pea hay	4	9.8	8.8	11.4	32.7	44.4	2.7
Barley hay	4	10.6	5.9	10.4	26.4	54.5	2.8
Timothy hay	68	13.2	5.1	6.8	33.4	51.8	2.9
Green fodder:							
Oat fodder	6	62.2	6.5	8.9	29.6	51.0	4.0
Corn fodder	126	79.3	5.8	8.7	24.2	58.9	2.4
Rye fodder	7	76.6	7.7	11.1	49.6	29.1	2.5
Red clover	43	70.8	7.2	15.1	27.7	46.2	3.8

^a The figures in this table have been compiled mainly from Farmers' Bulletin 22, U. S. Dept. of Agriculture.

In Table V the chemical composition of oats is shown in comparison with that of wheat, barley, and corn. The figures show that while oats are higher in crude fiber, due to the hull, the grain contains a high proportion of protein and fat, two very valuable constituents. Although practically one-third of the grain is hull, oats contain as much protein as wheat, nearly as much as barley, and more than corn. They are much higher in fat than either barley or wheat and are higher in ash or mineral matter than any of the other grains. As protein is a flesh-forming element and ash is used in the formation of bones, it can readily be seen why oats are so valuable for feeding to young and growing animals. The percentage of water as given for the different grains is that found in laboratory samples; ordinary commercial samples of all the grains usually show a higher moisture content.

The table also gives the chemical composition of oat hulls and oat kernels and of several products of the oatmeal industry. While

these oat feeds are not well known, their high feeding value, as shown, indicates that they should be used wherever they are obtainable at a reasonable price. There is considerable variation in the composition of different varieties of oats and of different samples of the same variety, largely due to differences in the percentage of hull. According to the composition of the kernel and the hull, as given, 100 pounds of a variety with 70 per cent of kernel would have 0.57 pound less protein, 1.44 pounds more crude fiber, 0.77 pound less carbohydrates, and 0.305 pound less fat than 100 pounds of a variety with 75 per cent of kernel.

The analyses of oat straw show that this roughage well deserves its reputation as the best of its class for feeding. In protein and fat it is higher in feeding value than wheat, barley, or rye straw, while in carbohydrates there is little difference. Pound for pound in its natural condition it is also materially better than corn stover, on account of the greater moisture content of the latter, but the dry matter in corn stover is rather richer in food constituents than that in oat straw.

Oat hay is shown to be slightly inferior to barley hay in feeding value, but it ranks higher than timothy hay in protein and fat, and in consequence is a slightly better feed. Hay made from the bearded varieties of barley is sometimes not readily eaten by stock on account of the beards; the waste thus occasioned makes oat hay fully as valuable, ton for ton, as hay made from bearded barley. The composition of several samples of hay made from oats and peas is also shown in the table. While the composition of this hay depends to some extent on the proportion of the two crops in the mixture, its high feeding value is apparent.

Oats cut green for feeding contain less water than either corn or rye. The superiority of oats over rye for soiling is particularly noticeable, as the oats are much higher in total food value. Green oats compare quite favorably, pound for pound, with green clover.

DIGESTIBILITY.

The feeding value of any article depends not only on its chemical composition, but on the digestibility of the matter it contains. It may contain a very high proportion of valuable food material, but part of this material may be in such form that animals are not able to digest it. While the hull of oats contains little that is digestible, it serves to lighten the grain ration and to give bulk, and in that way aids the complete digestion of the grain. As shown in Table VI, oats contain more digestible protein than barley or corn and nearly as much as wheat. This grain is also much higher in fat than barley or wheat, and practically as high as corn. In carbohydrates, the cheapest portion of the food, oats are considerably lower than

any of the other grains. Oat straw ranks much higher in digestible protein and fat than the straw from any of the other grains, and nearly as high in carbohydrates. It contains less protein than corn stover, but more of the other food constituents. Oat hay is higher than timothy hay in all the digestible nutrients.

TABLE VI.—*Digestible nutrients in oats, oat straw, and oat hay, as compared with other grains and grain products.*^a

Material.	Dry matter in 100 pounds.	Digestible nutrients in 100 pounds.		
		Protein.	Carbo-hydrates.	Fat.
Grain:	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Oats.....	89.0	9.2	47.3	4.2
Wheat.....	89.5	10.2	69.2	1.7
Barley.....	89.1	8.7	65.6	1.6
Corn.....	89.1	7.9	66.7	4.3
Roughage:				
Oat straw.....	90.8	1.2	38.6	.8
Wheat straw.....	90.4	.4	36.3	.4
Barley straw.....	85.8	.7	41.2	.6
Rye straw.....	92.9	.6	40.6	.4
Corn stover.....	59.5	1.7	52.4	.7
Hay:				
Oat hay.....	91.1	4.3	46.4	1.5
Timothy hay.....	86.8	2.8	43.4	1.4

^a Taken from Henry's "Feeds and Feeding."

UTILIZATION OF THE GRAIN.

USE OF OATS AS HUMAN FOOD.

Oats have been used as human food in northern Europe for many centuries. In Scotland oatmeal porridge, or groats, is one of the principal articles of diet. Hull-less oats are largely used as food in the mountainous districts of China, where the grain is not only used as porridge but is ground into meal and used in the making of bread and cakes. In the United States the manufacture and consumption of oatmeal have greatly increased in recent years. Most of the oatmeal now manufactured is more properly termed "rolled oats," though the cracked or cut grain, commonly known as "groats," is used to a limited extent.

Oatmeal when properly cooked is one of the cheapest and best of the cereal foods. Long cooking not only makes it more palatable, but greatly increases its digestibility. The Iowa Agricultural Experiment Station found that the average price per pound of three brands of oatmeal was slightly less than that of seven uncooked foods made from other cereals and little more than half that of seventeen brands of prepared cereals. Ten cents purchased a greater fuel value in the form of oatmeal than in the average of the other uncooked cereals, and nearly double that which could be obtained in the prepared cereals. The protein content of the oatmeal was greater than that of any of

the other cereal foods. Similar results showing the high food value and comparatively low cost of oatmeal are reported by several other agricultural experiment stations. It is generally recognized that most of the protein in oatmeal is readily digestible and that oatmeal is a valuable addition to the diet.

FEEDING THE GRAIN TO STOCK.

Oats have long been the staple grain for feeding horses. The high protein content furnishes a large amount of muscle-building material for the development of young animals and for the maintenance in good condition of older ones at heavy work. The protein and fat in the grain are largely digestible, while complete mastication and digestion are aided by the presence of a considerable amount of crude fiber in the hull. Oats are also excellent for feeding to cattle and sheep, especially to milch cows and ewes. They are not adapted for feeding to hogs on account of the large amount of crude fiber they contain, though crushed oats are sometimes fed to brood sows. Oats are often fed to poultry, forming a large part of the ration when not too high in price.

Probably by far the greater portion of the oats produced in the United States is fed to horses. In the opinion of many good horsemen no other feed produces as good results in keeping the animals in good condition and high spirits. Though the stimulating effect of oats on horses is generally recognized by horsemen, the attempts of chemists to find the active principle which produces it have been without results. Recent experiments with other feeds for work horses indicate that equally as good results can be secured where oats are in part replaced by corn, especially if a small amount of oil meal or other feed rich in protein is also used.

Oats are usually fed whole to horses. In the feeding of young colts and older animals with poor teeth, grinding or crushing the grain is of benefit. Musty grain should never be fed to stock. New oats should be fed with caution, as they are likely to have a decidedly loosening effect on the bowels. When oats are high in price, corn or other grains can be substituted in part in the ration for horses. Where brewers' grains are available, they are sometimes used for this purpose, as are barley and boiled rye. A recent experiment at the Michigan Agricultural Experiment Station in wintering work horses on cheap rations showed that corn, beet pulp, and bran can be used with profit in place of oats and timothy hay when these feeds are high in price. In an experiment at the Ohio station in substituting corn for oats in feeding work horses, it was found that when mixed clover and timothy hay was fed, ear corn was practically as efficient, pound for pound, as oats, and that the use of corn for work horses did not induce laziness or lack of endurance; nor did the use

of oats increase spirit or endurance. This experiment does not indicate that corn will give as good results as oats when fed with timothy hay alone, while in the feeding of brood mares with foals it is probable that oats are to be preferred. At the Iowa station results equally as good were secured at less cost when work horses were fed corn with a moderate amount of oil meal, gluten feed, or cottonseed meal as when fed a corn and oat ration of equal nutritive value.

The high protein content and readily digestible nature of oats make them excellent feed for dairy cows. Often, however, they are too high in price to feed with profit. According to a test conducted by the Wisconsin station, oats, pound for pound, are somewhat more valuable than bran for milk production. On this basis, with bran at \$25 a ton, oats are worth 44 cents a bushel for dairy cows. The grain is usually fed whole, though it is sometimes crushed or ground or fed in the form of corn and oat feeds. Some of the prepared feeds bearing this name, however, contain a large percentage of oat hulls and little of the grain. Oats are excellent for feeding to calves, particularly to those of the dairy breeds. They seldom form an important part of the ration of fattening cattle.

Oats are valuable for feeding to sheep, particularly to growing lambs and to ewes. While experiments show that this grain is only a little lower in feeding value than corn for fattening sheep, better results will be secured by feeding corn and oats mixed than oats alone. Oats are usually fed unground. Breeding ewes should be fed a half pound of oats, bran, or peas daily, the selection of the grain depending on the availability and the relative prices of the different feeds. Sheaf oats make good feed for sheep as well as for other stock. Ground oats can be fed to young lambs with excellent results.

As previously stated, on account of the large quantity of crude fiber in oats, this grain is not well adapted for use in feeding hogs. An experiment at the Wisconsin station showed excellent results when a ration of one-third ground oats and two-thirds corn meal was fed to growing pigs. A larger proportion of ground oats or the substitution of whole oats for the ground oats decreased the rate of gain and increased the cost. Ground or crushed oats are excellent for brood sows. They can be fed with best results in the form of slop, alone or in combination with bran, shorts, or peas.

Oats are quite largely used in poultry feeding, forming an important part of the grain ration of breeding stock. They are usually fed with other grains, their high protein content making them a valuable grain to combine with corn to balance the ration. They are little used for fattening poultry.

USE OF OAT BY-PRODUCTS.

As the principal article manufactured from oats is oatmeal, so the principal by-products of oatmeal manufacture are oat feeds. If these feeds contain a considerable proportion of small oats and broken kernels they may form a valuable addition to the ration. If, however, they are made up largely of oat hulls, as is often the case, they have about the same value as other coarse roughage and can not be considered as a concentrate. The corn and oat feeds on the market are usually made up of cracked corn and the refuse from oatmeal mills, which, as just stated, often consists largely of oat hulls. Their feeding value does not ordinarily justify the high prices at which they are usually sold.

UTILIZATION OF THE STRAW.

Oat straw is quite largely used for feeding to horses, cattle, and sheep. As a part of a maintenance ration, it is of considerable value, being nearly equal to corn stover (the stalks with the ears removed). If the straw is of good quality there will be less waste in feeding than with stover. It is higher in feeding value and more palatable than the straw from any other small grain. A common practice in feeding oat straw is to allow the animals to run to the stack at will. This is wasteful when roughage is high in price, as much of the straw will be trampled under foot and worked into the manure. A better plan is to feed the straw from mangers or open racks, as there is much less waste from feeding in this way. If roughage is low in price and straw is plentiful, however, the extra expense of hauling the straw to the racks will not be justified.

Where it is not utilized for feeding, oat straw is largely used for bedding for animals and in the formation of manure. When combined with the droppings from animals, it serves to hold the liquid manure, gives bulk, and adds humus and considerable fertilizing material to the soil. At the present prices of commercial fertilizers, \$3 a ton is a conservative estimate of the value of oat straw as a fertilizer. It is altogether too valuable to burn, a common practice in some sections. Oat straw is not extensively used in manufacturing, rye, wheat, and rice straw being the kinds that are commonly utilized.

USE AS HAY AND PASTURE AND FOR SOILING.

A considerable acreage of oats, either alone or in combination with peas or vetch, is harvested annually for hay. Oat hay is produced to some extent in the South, particularly in those sections where the crop does not produce grain satisfactorily, and in the Pacific Coast States. With Canadian field peas, oats are grown for hay in the northern portion of the United States and in Canada, while this crop is grown with

vetch in the Pacific Northwest and in a very limited way in the South. If cut when the grain is in the milk, oats make a very palatable and nutritious hay, which is readily eaten by stock of all kinds. The addition of peas or vetch increases the yield of hay as well as its feeding value. Oat and pea hay is particularly well liked by sheep and dairy cows and is highly recommended for feeding to these animals. A common proportion is 1 bushel of peas to $1\frac{1}{2}$ bushels of oats, sowing $2\frac{1}{2}$ bushels of the mixture to the acre. The feeding value of the hay depends largely on the proportion of pea vines it contains, but the mixture just given or equal parts of the two grains is usually regarded as most satisfactory. Hay from oats alone or from oats and peas is cut and cured like other hay, though if the crop is heavy it may be found rather difficult to cure. Curing in the windrow or cock, with as little handling as possible, is desirable in order to retain the leaves and pods on the pea vines. The hay should be cut before many of the pods ripen; otherwise the peas will shell out in handling and a valuable portion of the crop will be lost. The grain binder may be used in harvesting if the crop is allowed to become nearly ripe before cutting and is partially cured before shocking. A good crop of oats should yield from 2 to $2\frac{1}{2}$ tons of cured hay, while peas and oats together should make from $2\frac{1}{2}$ to 3 tons.

Oats alone or in combination with either peas or vetch make an early, nutritious, and heavy-yielding soiling crop. If several seedings are made in succession at intervals of a week or two, the crop is in good condition for use over a considerable period. If more is grown than can be used for feeding green, the crop may be allowed to mature and be cut for hay, or it may be used as pasture. Oats furnish abundant pasture for sheep and hogs, which is available quite early in the season. If peas are sown with the oats, the crop should be allowed to make considerable growth before the hogs are turned in on it, as the young pea vines are easily broken off and destroyed. Sheep do less injury in this way and can be turned in on the pasture early in the season.

Mutton or pork may be very cheaply produced by allowing the peas and oats to ripen and then pasturing off the crop with sheep or hogs. This combination is particularly well liked by sheep, and as they make rapid growth and cheap gains upon it, it should be more generally used. As the crop is pastured off it costs nothing to harvest and the land is enriched, as practically all of the plant food taken from the soil is returned, together with the nitrogen taken from the air by the pea vines.

USE AS A NURSE CROP AND AS A COVER CROP. -

Oats are frequently used as a nurse crop for clover and grass, and in some sections for alfalfa. This use is only incidental, however, as the oats are sown primarily for the production of grain, while the position of this crop in the rotation immediately preceding the meadow or pasture crop makes it desirable, and in some cases necessary, to sow grass or clover seed with it. When used as a nurse crop rather less seed should be sown than when not so used, while early harvesting and the growing of early varieties are advisable. A less frequent use of oats is as a cover crop in orchards, to protect the roots of the trees by shading them in late summer and by forming a mulch and holding the snow in winter. The cover crop also serves to check the growth of the trees and to insure thorough ripening of the young wood before cold weather. Canada field peas or vetch make a valuable addition to oats when used for this purpose.

SUMMARY.

The oat crop of the world is nearly 3,700,000,000 bushels annually, most of which is produced in Europe and North America. The principal oat-producing countries are the United States, European Russia, Germany, France, and Canada. In the United States the greater portion of the crop is grown in the upper Mississippi Valley. Illinois, Iowa, Wisconsin, Minnesota, and Nebraska are the leading States in the production of oats. The annual crop, 1900-1909, of the United States is about 900,000,000 bushels.

The market grades of oats depend on the color of the grain and its freedom from mixture and from dirt.

The legal weight of a bushel of oats in most of the States is 32 pounds.

About 2 pounds of straw are usually produced to 1 pound of grain. The proportion of straw may be materially reduced, however, in some varieties and in some seasons, or it may be materially increased. The hull usually comprises 30 to 35 per cent of the grain, though the range is from little more than 20 per cent to about 45 per cent.

Analyses show that oats are higher in protein than corn and about equal to wheat and barley. They are higher in ash than any of the other grains, and considerably higher in fat than either barley or wheat. On account of the hulls, oats contain the highest percentage of crude fiber, an undesirable element. Oat straw contains more protein and more fat than corn stover or the straw of any other small grain.

Oats are quite largely used as food for man in the form of oatmeal, or rolled oats, a highly nutritious cereal food. Most of the crop, however, is used for feeding to stock, particularly to horses. No other grain is so popular for feeding to this class of animals. Good results are also secured from feeding oats to dairy cows, sheep, and poultry, though the price of this grain is often too high to justify such use.

Oat straw is more palatable and more nutritious than the straw of any other grain and is nearly equal to corn stover. In addition to its use as a feed, it is largely used for bedding and for the formation of manure. Its fertilizing value is about \$3 a ton.

Hay made from oats or from oats and peas is both palatable and nutritious, being higher in feeding value than timothy hay. These crops can also be used as pasture or cut green for feeding to stock. Sheep do particularly well on oats and peas, either when cut for hay or when used as pasture.

As oats frequently precede grass or clover in the rotation, they are often used as a nurse crop. They are sometimes used as a cover crop in orchards.

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