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grass
and grass seed production

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COOPERATIVE EXTENSION SERVICE IN AGRICULTURE AND HOME ECONOMICS OF THE STATE OF IDAHO, UNIVERSITY OF IDAHO EXTENSION DIVISION AND UNITED STATES DEPARTMENT OF AGRICULTURE COOPERATING

Grass and Grass Seed Production

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Importance of Grasses

The term "grass" applies to a wide variety of crops. The grass family is of greater importance in agricultural production than any other botanical group of plants. It includes not only the perennial grasses ordinarily used in hay meadows and pastures but also annual grasses used in the production of our cereals such as wheat, oats, barley, and the coarse grasses such as corn and the sorghums. In this publication, the term grass is confined to the forage grasses, that is, those grasses used for the production of hay and pasture.

The forage grasses are important for providing feed for livestock, for lawns, for soil improvement purposes, and for preventing soil erosion.

The relative importance of grasses in American agriculture is shown in Table 1. The National Resources' Planning-Board estimates that 372,000,000 acres of land in the United States are devoted to the production of the principal crops of the country. Of this acreage 67,800,000 is used for the production of hay. This figure is exceeded only by corn from the standpoint of land devoted to any other single crop. Corn occupies in excess of 26 percent, hay in excess of 18 percent of the crop land of the country.

The total land in farms in the United States is estimated at 987,000,000 acres. Of this acreage over 27 percent is occupied by non-plowable pasture, 11 percent by plowable pasture, and more than 8 percent by woodland pasture. A summary of the acreages shows that almost 54 percent of the land in farms is used for some type of forage production. This does not include corn, the sorghums, or the cereals which are also used quite extensively for forage production.

The data reported in this publication resulted from cooperative studies of the University of Idaho, Agricultural Experiment Station with the Soil Conservation Service, Nursery Division, U.S. Department of Agriculture.

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The general task of producing forage for livestock is still further emphasized by taking into consideration lands not in farms. The acreages involved are large. Stated in millions of acres they are: private grazing land 126, public grazing land 203, private forests that are grazed 143, and public forests grazed 106. The total of these grazed areas amounts to 578,000,000 acres.

The total acreages of land in farms and not in farms used for some form of forage production in the United States adds up to 1,109,800,000 acres. Of this figure, two categories, namely, the land used for hay production and the land used for plowable pasture, demand periodic reseeding. The other categories indicated, such as non-plowable pasture on farms, and the various acreages used for grazing not in farms also demand a certain amount of reseeding. When all these acreages are taken together it is evident that a rather large amount of seed is necessary in order to maintain the grazed acreages of the country.

Table 2 summarizes the major uses of Idaho farm lands. As contrasted with the national average of 54 percent the tabulations for the state show that almost 69 percent of the land in Idaho farms is used for some type of forage production. More acreage is in hay production than in any other single crop. The combined acreage of winter and spring wheat in 1945 was 1,040,830 acres. The harvested hay acreage exceeded this figure by 61,804 acres. The large acreage in hay and pasture provide outlets for Idaho produced seed.

Table 1—Major uses of land in farms in the United States showing the importance of forage crops used either as hay or in pastures.

Principal crops	Acres (Millions)	Percent of total land in crops	Percent of total land in farms
Corn	97.7	26.26	9.89
Hay	67.8	18.23	6.87
Wheat	62.0	16.67	6.28
Cotton	43.2	11.61	4.38
Oats	36.5	9.81	3.70
Fruits and nuts	6.1	1.64	0.62
Vegetables	5.8	1.56	0.59
Tobacco	1.9	0.51	0.19
Barley, sorghums, etc., and others	51.0	13.71	5.17
Total in crops	372.0	100.00	37.69
Plowable pasture	109.0		11.04
Non-plowable pasture	270.0		27.36
Woodland pasture	85.0		8.61
Woodland not plowable	65.0		6.59
Idle, fallow, waste	86.0		8.71
Total in farms	987.0		100.00

Table 2.—Major uses of land in farms in Idaho showing the importance of forage crops used either as hay or in pastures.

Classification of land use		Acres	Percent of total land in farms
Cropland harvested—excluding hay		2,339,027	18.71
Total hay harvested		1,102,634	8.82
Alfalfa	798,758 acres		
Wild hay	134,838 acres		
Clover and Timothy	122,498 acres		
Other tame hay	46,450 acres		
Cropland in pasture only		322,286	2.58
Other land pastured		6,229,520	49.82
Woodland pastured		946,253	7.57
Idle or fallow		800,155	6.40
Crop failure		25,496	0.20
Woodland not pastured		113,881	0.91
All other land		624,080	4.99
Total land in farms		12,503,332	100.00

Grassland Agriculture

A new term, "grassland agriculture," has been introduced into the vocabulary of the farming public. This term refers to the adjustment of crop and livestock production to a grassland base. The development of "grassland agriculture" applies to a long felt need for making adjustments in agricultural production so as to establish a better relationship between the production of cash crops and soil building crops. Cash crops are often soil depleting. These adjustments may or may not result in increases in livestock populations. The preservation of soil fertility calls for a greater use of grass and legume crops. The fibrous roots of grasses have a favorable effect on the structure of the soil. Grasses are frequently grown in combination with legumes for the production of hay and pasturage. This enables the utilization of the good features of both of these important forage crops. During the war period emphasis was placed on the production of annual and soil depleting cash crops. In many agricultural areas soils have actually been depleted to the extent where the maintenance of these soils in a productive condition will demand a higher percentage of grassland in future years than is now used. The recent need for food crops has frequently been the direct cause for improper land use. Large areas especially adapted to perennial forage production have been pressed into the production of food crops. The needed adjustment towards better land use can be expected to lead to greatly increasing demands for the seeds of both grasses and legumes.

Additional acreages of grasses and legumes on crop land provide supplemental feed which will serve to relieve range lands adjacent to farms. The threshed grasses as well as aftermath grazing of grass areas cut for seed provide valuable feed for livestock.

Similar problems are encountered in growing grasses and legumes. In many instances it is advantageous to grow the two in mixtures. Grass-legume mixtures are commonly used in the establishment of pastures, and in many cases it is desirable to use them for the production of hay. The term grassland agriculture applies to the production of both grasses and legumes either in pure stands or in mixtures.

Possibilities for Grass Seed Production In Idaho

The successful production of grass seed is dependent on many factors. Climatic and soil conditions required for the growth of specific grasses are of primary importance. The great variety of conditions with regard to these factors in Idaho makes it possible for the various areas of the state to produce different kinds of grasses. A second consideration in the production of grasses is that such production must be regarded as a specialized enterprise. Forage grass seed production demands special knowledge and aptitudes on the part of the producer. In many cases special types of equipment are also required.

A high percentage of the crop land in the main grain producing areas of the state are given over to the production of cash crops. This is the case especially in the Palouse and in the dryland areas of eastern Idaho. The need for grasslands from the standpoint of soil conservation is great in these areas. It may not be to the advantage of these areas to increase their livestock populations to utilize all the grasses which can be grown. Grass production need not be limited by low feed requirements of an area when these grasses can be grown for seed and marketed in that form. Grass provides an alternate cash crop. It also brings about a desirable diversification in the cropping enterprise; and from the standpoint of preserving the fertility level of the soils utilized, grass in the rotation adds a much needed humus-accumulating crop.

The agricultural lands of Idaho are separated by long distances from the main consuming centers of the nation. This condition makes it more profitable for Idaho farmers to produce commodities that have a high unit value. This idea is not new in the state. The importance of our alfalfa and clover seed producing programs is based on this important point. The dryland areas can profit from it by increasing their acreages producing grass seed. Grass seed can also be produced economically in the irrigated areas of the state. In some of these irrigated areas the prevalence of wire worm injury, particularly on potatoes and beans, may result in the abandonment of some of the acreage now used in the production of clover seed. Experiments show that wire worm populations increase rapidly in clover fields. With the abandonment of clover seed production, additional acreages will be found for production of forage grass seed.

The greatest outlet for grass seeds produced in Idaho is within the state. There is a continual home demand for grasses in all our agricultural areas. In the dryland sections well supplied with moisture, it can be expected that greater use will be made of sweet clover-grass and alfalfa-grass mixtures than in the past. This will provide definite outlets for grass seeds. Alfalfa-grass mixtures are replacing straight alfalfa for hay production in some of the irrigated sections. This is particularly true on sloping land subject to soil erosion. The establishment of rotation and permanent pastures provides a stable outlet for grass seed. Grass seed will also be in demand for the establishment of permanent vegetative cover for abandoned croplands and in range reseeding programs.

The Establishment of Grasses

Soil Preparation

The primary objective of soil preparation for any crop is to provide a favorable seedbed. Most forage grasses have small seeds and produce rather small seedlings which are slow in establishing themselves. This set of conditions demands that the seedbed should favor germination and rapid emergence of the seedlings.

A good seedbed should above all be firm. A well compacted seedbed makes it possible to provide the close contact between the small grass seeds and the soil particles. This is essential to germination. A firm seedbed enables the seeds placed in it to absorb moisture rapidly. It permits the roots of young seedlings to find ready anchorage to insure the absorption of moisture and nutrients. An open, loose seedbed favors rapid drying of the surface and makes it difficult to place the seeds at the desired depth in the soil at seeding time. Positive control of seeding depth leads to a saving of seed and places the seed at the most favorable place for germination and emergence. As a general rule grasses should not be seeded deeper than is necessary to place them in contact with moisture in the surface inch of the soil. The seeding of grasses on loose seedbeds results in the placement of many seeds at depths so great that the reserves in the seeds will be exhausted prior to emergence.

The time of plowing is frequently related to the type of seedbed that can be produced. In most cases fall plowing is preferred over spring plowing. Fall plowing provides ample time for the settling of the soil. This in itself is important. In addition, when the land is plowed in fall it allows for the early working of the field the following spring and provides time for killing several crops of young weeds prior to seeding time. Several workings of the field prior to seeding will not only kill a lot of weed seedlings but also serves to compact the soil. The ideal seedbed should be firm underneath with only an inch or so of loose soil on top to provide cover for the seed. Excessive pulverization of the surface soil should be avoided in that it creates conditions favorable to soil erosion losses.

Where it becomes necessary to seed grasses on spring plowed land such plowing should be done as early in the season as the condition of the soil will permit.

The selection of implements for working the field after plowing depends upon the conditions of the soil. A disk harrow, and especially a double disk, does good work in cutting the soil following fall plowing. It also serves to compact the lower levels of the soil in the case of spring plowing. Avoid excessive loosening of the soil as with a spring tooth harrow. Handle the soil so that the winter and early spring moisture present can be held and kept near the surface. If the soil is loose, rolling prior to seeding is a good practice.

Grasses may follow grain or cultivated crops in the irrigated sections of the state or in areas well supplied with moisture. Highest grass seed yields can be expected where the crop follows a legume. In dry areas it is advisable to introduce a fallow prior to the seeding year. Introducing a fallow gives time for the preparation of a good seedbed. It also provides an opportunity for the elimination of competing weeds, and allows for the accumulation of moisture and soil nitrates for the use of the grasses during the critical year of establishment. Fallow land should be left in a rough condition during the winter months. This will reduce danger from winter and early spring erosion. Early spring working is desirable for the reasons already indicated.

Time of Seeding

Early spring is generally more favorable for the establishment of grasses than any other time of year. Where excessively weedy land must be used it is well to delay seeding until several stands of weeds have been eliminated by cultivations prior to seeding. However, the seeding date should not be delayed too long. Grasses have light seeds. The seedlings produced are small and greatly dependent upon moisture in or near the surface of the soil. Such surface moisture is more likely to be abundant during early spring than later in the season. Again a well compacted seedbed must be stressed in that it is instrumental in holding such moisture near the surface. Grasses as a class grow best during cool weather. Early seeding will allow the seedlings to establish themselves prior to the time when high temperatures may be expected. Such high temperatures are associated with high rates of evaporation from the soil and water losses from the young seedlings.

The practice of seeding during the middle of the summer, following the removal of an early crop such as early potatoes or barley, can be used to advantage in areas such as the lower and middle Snake river valley where the season is sufficiently long for this type of double cropping. This practice obviously is limited to areas favored with relatively long growing seasons and where irrigation water is available during the summer months. Where summer seedings are used it is well to supply the soil with a sufficient amount of moisture prior to the preparation of the seedbed to enable the plants to emerge without having to resort to irrigating the crop prior to emergence. The application of water prior to emergence frequently leads to a crusting of the soil which may interfere with the emergence of the grass plants. Favorable moisture conditions must be maintained after emergence so that the seedlings can make rapid progress during the remainder of the growing season. The grasses should be up by the last week in August so that the plants will have ample time to become well established before cold weather. The great advantage of this method of seeding is that a grass crop can be established without interference with other cropping practices; furthermore, the grasses can be started without having to compete with companion crops.

Summer seedings following an early grain crop may be drilled in the stubble without any tillage operations, provided that the field is relatively free of weeds. Where such seedings follow early row crops, light disking and floating are the only tillage operations required before seeding. If plowing is resorted to, it should be shallow. Deep plowing frequently results in the development of a loose seedbed.

Summer seedings are likely to be more successful in the establishment of relatively coarse grasses such as mountain brome, smooth brome, or tall fescue than with the fine-leafed grasses such as red fescue, sheep fescue or big bluegrass.

Fall seeding is sometimes resorted to in dry areas. When it is used, it is best to delay the date late enough so that the seed will not germinate before spring when conditions favorable to growth may be expected. A hazard encountered in fall seeding is that periods with unseasonably high temperatures combined with favorable moisture conditions may lead to the germination of the seed and to emergence. Then, unless such periods are followed by mild weather, seedlings emerging during late fall or winter are frequently killed before the coming of spring. This hazard, together with the fact that fall seeded plants generally encounter a greater amount of competition from weeds than spring seeded plants, must be taken into consideration. Another hazard involved in fall seeding is the possibility that rodents may destroy many seeds during the fall and winter months.

Fall seeding is practicable where grasses are to be established on rough land on which a definite seedbed cannot be prepared. In such places the covering of the seeds by the action of the elements during the winter and early spring months adds greatly to their chances of producing surviving plants. Covering or even partially covering the seeds greatly encourages germination and increases the ability of the seedlings to become established.

Method of Seeding—With or Without Companion Crops

The chances of establishing good and vigorous stands of grasses are much better where such grasses are seeded alone rather than with a companion crop.* This is true in all areas of the state.

The production of grass as a seed crop demands the establishment of uniform stands. It is difficult to obtain such stands where the grass seedlings must compete with the ranker companion crops even when moisture conditions can be maintained at a favorable level as they can under irrigation. It is even more difficult where rainfall must be relied upon as the only source of moisture. In the

* The term "companion crop" is recommended to replace the older term "nurse crop."

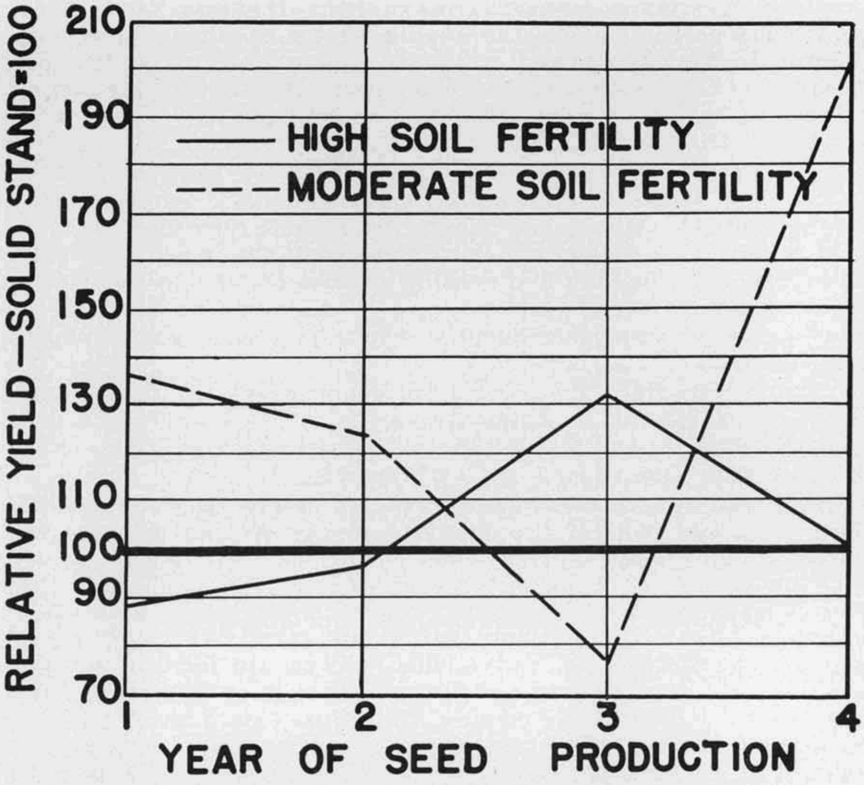

Figure 1. Relative seed yields of smooth bromegrass grown in solid stands and in cultivated rows for a period of 4 years on soils of high and moderate levels of fertility. The yields of the solid stands are placed at 100.

dry areas of the state, good, uniform stands of grasses cannot be consistently produced by seeding them with companion crops. In most seasons there is not enough moisture for the survival of two crops. The weaker crop of the two is rapidly crowded out. The companion crop has not only the advantage with regard moisture but also takes most of the sunlight.

Obtaining uniform stands is of less direct consequence in the establishment of pastures, hay-producing mixtures, or mixtures for green manure purposes than in grass seed production. Companion crops can often be used to advantage with these crops if there is enough moisture for their demands.

When a companion crop is used, the rate of seeding of the companion crop should not be higher than 30 pounds per acre. This will make conditions somewhat more favorable for the grass crop in that competition for light and moisture will be slightly reduced. One way of reducing the rate of seeding of the companion crop is to seed it in alternate drill rows.

Table 3.—Hay and seed yields of grasses grown for a period of 4 years in solid stands and in cultivated rows on fertile soil, Field 8, University Farm.

Grass	Year*	Hay yields, tons per acre Solid stands	Cult. rows	Relative yields†	Seed yields pounds per acre Solid stands	Cult. rows	Relative yields†
Crested wheat	1	2.32	2.61	113	710	662	93
	2	2.28	2.59	114	905	1006	111
	3	1.45	1.80	124	314	236	75
	4	1.44	1.65	115	336	352	105
Ave.		1.87	2.16	116	566	554	98
Smooth brome	1	2.38	3.06	129	842	745	88
	2	2.61	2.80	107	520	506	97
	3	1.07	1.42	133	198	262	132
	4	0.39	0.61	156	107	108	101
Ave.		1.61	1.97	122	417	405	97.
Tall meadow oats	1	2.20	2.10	95	245	462	189
	2	2.25	2.13	95	454	368	81
	3	0.65	1.33	205	114	127	111
	4	0.91	1.35	148	100	125	125
Ave.		1.50	1.75	117	228	271	119
Orchard	1	0.71	1.07	151	60	137	228
	2	2.02	2.73	135	479	654	137
	3	0.51	1.58	310	74	223	301
	4	0.62	1.18	190	79	167	211
Ave.		0.97	1.64	169	173	295	171
Meadow fescue	1	1.20	1.02	85	615	515	84
	2	1.20	1.30	108	553	456	82
	3	0.50	0.76	152	155	156	101
	4	0.25	0.50	200	40	112	280
Ave.		0.79	0.90	114	341	310	91

* Stands established in 1936, years 1-4 indicate yields obtained from 1937-1940.
† Yields of solid stands taken at 100.

Method of Seeding—Solid or Row Stands

Grasses intended for seed production may be grown either in solid stands or in cultivated rows. In this discussion the term "solid stands" refers to stands established either by drilling or by broadcasting. This method of seeding gives fairly complete ground cover. The term "cultivated rows" refers to growing the grasses in rows with cultivation at intervals frequent enough to keep down weeds in the spaces between the rows. In the experiments to be reported the distance between the rows was 3 feet at Moscow and Tetonia. At Aberdeen the spacing was 2 feet.

The choice between growing grasses in solid stands or in cultivated rows is conditioned by several factors such as the kinds of grass grown, the fertility level of the soil used, the topography of the land, and whether the crop is being grown under natural rainfall or under irrigation.

Table 3 gives the hay and seed yields of five grasses grown in solid and row stands over a period of 4 years. The field on which these plots were grown had a high level of soil fertility. The high hay yields and seed yields during the first 2 years of the test bear

Table 4.—Hay and seed yields of grasses grown for a period of 5 years in solid stands and in cultivated rows on a soil of moderate fertility, without nitrogen fertilization, Field 5, University Farm.

		Hay yields, tons per acre			Seed yields, pounds per acre		
Grass	Years*	Solid stands	Cult. rows	Relative yields†	Solid stands	Cult. rows	Relative yields†
Mountain brome	1	2.48	2.93	118	743	679	91
	2	1.08	.91	84	614	285	46
	3	.76	.99	130	242	396	164
	4	.38	.89	234	117	249	213
	5	.16	.39	244	41	162	395
Ave.		.97	1.22	126	351	354	101
Big bluegrass	1	1.03	1.60	155	289	622	215
	2	.49	2.06	420	122	728	597
	3	.84	1.65	196	81	33	41
	4	.23	1.10	478	31	162	523
	5	.18	.94	522	14	195	1,393
Ave.		.55	1.47	267	107	348	325
Orchard grass	1	.62	2.60	419	91	550	604
	2	.10	1.13	1,130	10	218	2,180
	3	.24	.76	317	16	79	494
	4	.05	.75	1,500	3	155	5,167
	5	.28	.43	154	33	96	291
Ave.		.26	1.13	435	31	220	710
Smooth brome	1	1.79	3.71	207	407	558	173
	2	.70	1.27	181	141	175	124
	3	.54	.50	93	50	38	76
	4	.39	.62	159	37	74	200
	5	.23	.39	170	41	83	202
Ave.		.73	1.30	178	135	186	138
Crested wheat	1	1.31	2.41	184	322	781	243
	2	.55	1.40	255	100	285	285
	3	.41	.86	210	138	229	166
	4	.37	.79	214	20	92	460
	5	.45	.71	158	52	102	196
Ave.		.62	1.23	198	126	298	237

* Stands established in 1942, years 1-5 indicate yields obtained from 1943-1947.
† Yields of solid stands taken as 100.

this out. Special attention should be given to the relative yields with the two methods of seeding in the first 2 years. Crested wheat, smooth brome, and meadow fescue produced higher yields in the solid than in the row plantings. Tall meadow oat grass produced more seed on the row plantings than on the solid seedings the first year but not during the second. Orchard grass gave significantly higher yields on the row planting in all years. The relationship of age of stand to yields will be discussed in another section.

Table 4 gives the hay and seed yields of five grasses grown in solid and row stands over a period of 5 years. As contrasted to the results reported in Table 3, namely yield data obtained with a high level of soil fertility, the data reported in Table 4 were obtained from a field of only a moderate level of fertility. The differences resulting from the two methods of seeding are pronounced. Again the results obtained during the first 2 years of the test should be given major consideration. In four of the grasses, that is, with the

Figure 2. Orchard grass on field 5 on the University farm in solid and row stands during the first year of seed production. The solid stand yielded 91 pounds, the cultivated row stand 550 pounds of seed per acre. Note the lack of fertile culms on the solid stand.

exception of mountain brome grass, very significant increases in both hay and seed yields were obtained by growing these grasses in cultivated rows. Again, as in the previous test, orchard grass showed the greatest increase due to row seeding. However, the increases in the case of big bluegrass, crested wheat and smooth brome are also quite pronounced. Figure 1 gives a graphic presentation of the relative seed yields of smooth brome-grass in solid stands and in cultivated rows for a period of 4 years in fields of a high and only a moderate level of fertility. Since the yields obtained from the solid stands are placed at 100, the points on the graph above the 100 line indicate yield increases due to row culture; points below the 100 line show yields favored by solid stand culture. Seed yields during the third year on the soil of moderate fertility were low, only 50 pounds per acre on the solid and 38 pounds on the row crops.

A third set of data on this same topic is presented in Table 5. The same grasses and same arrangement of plots were used in this case as in the case of the data reported in Table 4. The only difference was that 150 pounds of ammonium sulphate were applied to these plots each year. As in the case where these grasses were grown without nitrogen fertilization significant increases were obtained in all cases except with mountain brome by growing the grasses in cultivated rows. In the case of mountain brome the differences in yields obtained between solid and row stands did not differ materially.

The yield increases due to row seeding and cultivation were relatively greater on the unfertilized than on the fertilized plots. This indicates that growing the grasses in cultivated rows compensates in part for the low availability of nitrogen on the field used for this experiment. The hay yields from the plots reported on in Tables 4 and 5 correlate rather closely with seed yields. Both the seed and hay yields of orchard grass responded materially to cultivated row culture. Figure 2 shows the response of orchard grass to row culture.

On soils of high fertility levels, grass seed production can be recommended with the use of solid stands except for certain grasses of which orchard grass is one. It is less expensive to grow grasses in solid stands than in cultivated rows. Furthermore, the handling of row crops on sloping land presents definite difficulties from the standpoints of cultivation and soil erosion hazards. Availability of nitrogen is important in all grass seed production. When grasses are grown in solid stands, nitrogen fertilization is even of greater importance than when they are grown in rows. On soils of only moderate levels of fertility it is evident from the yield data presented that grass seed crops should be grown in cultivated rows. On such soils the increases in yields due to row culture and cultivation are so pronounced that it would not be economical to grow the crop in solid stands. One exception to this statement, as evidenced by the yield data presented, may be found in rapidly developing species such as mountain brome grass.

The results obtained on the University farm with solid and row culture without and with the application of nitrogen fertilizers are well summarized in Figures 3, 4, and 5. The data shown in graphical form in these figures were obtained from Field 5, that is the field with only a moderate level of fertility. They are based on the average yields of five type species; namely, mountain brome, big bluegrass, orchard grass, smooth brome, and crested wheat, over a period of 5 successive years of seed production. These figures show the effects of method of culture, solid and row; the response to the application of 30 pounds of nitrogen in the form of 150 pounds of ammonium sulphate annually; the effects of age of stands on seed yields and agronomic characteristics. The stands on which these data are based were established in 1942. The 5 years of seed production were from 1943-1947, inclusive.

Figure 3 shows the average seed yields for the 5 years of seed production under four different methods of management. The yields show significant upward trends from solid stands without nitrogen applications—the lowest in all the years—through solid stands with nitrogen, cultivated rows without nitrogen, to cultivated rows with applications of nitrogen giving the highest yield in all years of the test. The effect of age of stand is quite evident. Yields are highest with all systems of management during the first year of seed production and then drop off by successive years to the fourth and fifth year.

Figure 4 gives the average heights of the grasses for each of the 5 years of the test under the different systems of management.

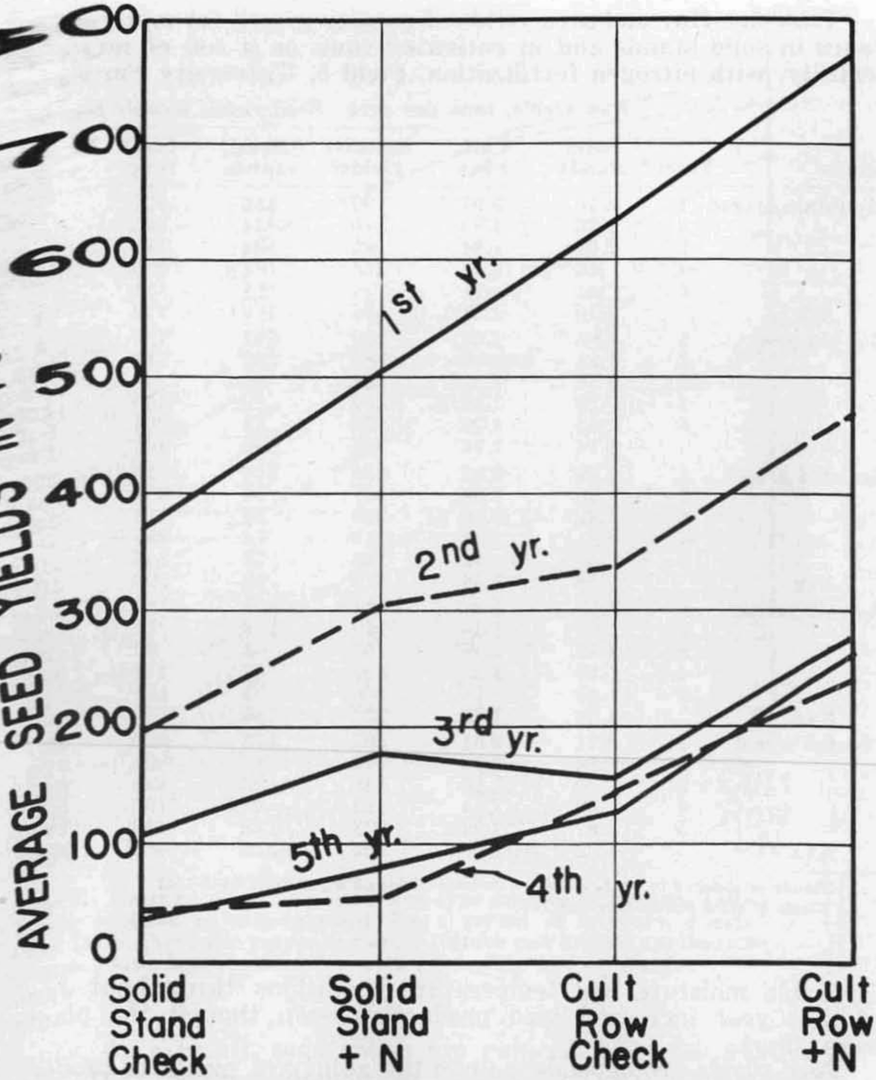

Figure 3. Average seed yields of five type species of grasses grown under four systems of management for a period of 5 years, Field 5, University farm. Response is shown to row culture and applications of 30 pounds of nitrogen per acre annually. Seed yields decrease with advancing age of stands.

The plant height response follows the same pattern as the yield data presented in the previous figure with one exception. The yields during the fourth and fifth year did not show material differences while the heights of the plants during the last season of the test were significantly lower. Dry conditions during May of the last season, 1947, account for the shortness of the plants. Exceptionally

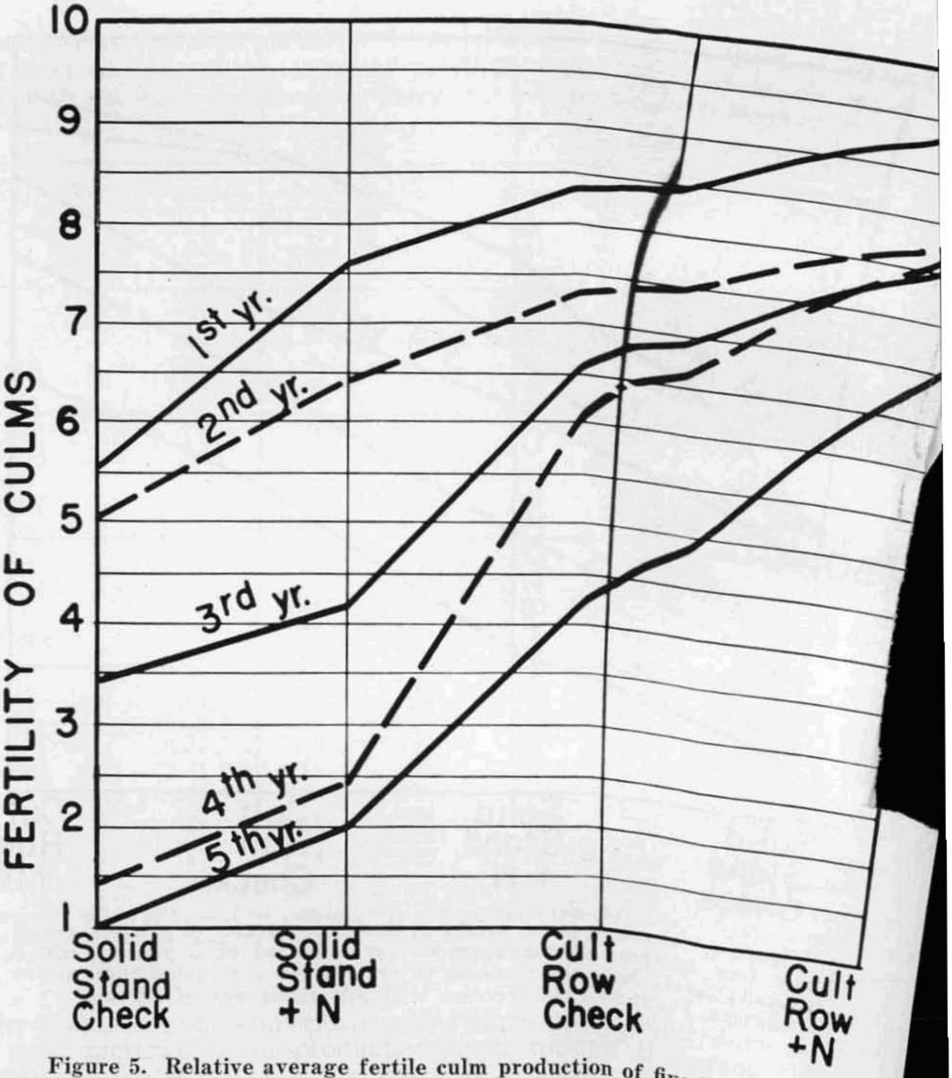

Figure 5. Relative average fertile culm production of five type species of grasses grown under four systems of management for a period of 5 years. Field 5. University farm. Note the response to row culture and fertilization. Fertile culm production decreases with advancing age of stands.

meadow fescue definite increases from rows are in evidence for the third year of seed production. The production of grasses in rows in the irrigated portions of the state facilitates uniform water distribution.

Table 7 gives the seed yields of four grasses grown under high altitude, dryland conditions at the Tetonia Branch Station in solid stands and in cultivated rows with and without the addition of

Table 6.—Seed yields of six grasses grown under irrigation for a period of 3 years in solid stands and cultivated rows at the Aberdeen Branch Station.

Grass	Year*	Seed yields in pounds per acre: Solid stands	Cult. rows	Relative yields†
Meadow fescue	1	1,268	845	67
	2	541	532	98
	3	348	634	182
Ave.		719	670	93
Orchard grass	1	220	200	91
	2	114	237	208
	3	117	229	196
Ave.		150	222	148
Tall meadow oat	1	124	236	190
	2	98	206	210
	3	95	171	180
Ave.		106	204	192
Smooth brome	1	671	1,193	178
	2	266	623	234
	3	144	506	351
Ave.		360	774	215
Crested wheat	1	358	978	273
	2	124	505	407
	3	92	655	712
Ave.		191	713	373

* Stands established in 1936, years 1-3 indicate yields obtained from 1937-1939.
† Yields of solid stands taken as 100.

20 pounds of nitrogen in the form of 100 pounds of ammonium sulphate per acre. All the grasses tested except mountain brome showed significant yield increases due to row culture. As at Moscow the greatest relative increases due to row culture were obtained without nitrogen fertilization. The case of mountain brome is interesting in that no increases in seed yields due to row culture were obtained where this grass was grown without fertilization while the application of 20 pounds of nitrogen per acre shifted the seed yields in favor of row culture.

Rate of Seeding

Table 8 gives the seed yields obtained from four different grasses seeded at five different rates. Table 9 gives the hay yields for these same species. These yields were obtained from plots on Field 8 of the University farm at Moscow. Soil of the field was of a high fertility level. The yields reported are from solid stands. The hay yields obtained with the different per acre rates of seeding listed in Table 9 are remarkedly alike for all the rates employed. The fact that as much hay was harvested from the lower rates as from the higher rates of seeding gives evidence that more seed is frequently used than necessary for production of maximum yields. Producers frequently attempt to compensate for poor seedbed preparation by increasing the seeding rate. There is no substitute for a good seedbed. The number of plants that will survive for crop production is influenced by the growth conditions prevailing in any given field. Under the conditions of the experimental seedings reported here a sufficient number of plants was established with the lower rates of seeding to take full advantage of all moisture and fertility available to the plants. The higher rates reported served only to increase the costs of seeding without increasing returns. Results of the rate of seeding test are shown graphically in Figure 6.

A glance at Table 8 and Figure 6 shows that the seed yields of smooth brome grass were actually decreased with the use of more than 4 pounds of seed per acre. The reason for this is that the higher rates favored the more rapid development of a sod-bound condition with its yield-depressing effects. This is to be expected especially in a strong sod-producing grass such as smooth brome. Orchard grass produced a higher percentage of fertile culms on the 4-pound rate than at higher rates of seeding. This fact more than compensated for the larger number of plants established per unit of area with the higher seeding rates. Crested wheatgrass produced higher seed yields with the employment of 10 pounds of seed per acre than with lower rates. The drought-resistant character of this grass no doubt entered into its performance in that a larger number of plants per unit of area could be supported with the amounts of moisture available to the plants of this species. A short-lived species such as meadow fescue gave its best per-

Table 7.—Seed yields of four grasses grown under dryland conditions at the Tetonia Branch Station in solid stands and cultivated rows without and with the application of 100 pounds of ammonium sulphate per acre.

		Seed yields in pounds per acre					
		Without fertilization			With fertilization		
Grass	Year*	Solid stands	Cult. rows	Relative yields†	Solid stands	Cult. rows	Relative yields†
Crested wheat	1	313	373	119	345	390	113
	2	258	501	194	290	428	148
	3	129	261	202	113	208	184
Ave.		233	378	162	249	342	137
Smooth brome	1	121	334	276	89	235	264
	2	161	282	175	129	167	129
	3	16	55	344	25	82	328
Ave.		99	224	226	81	161	199
Mountain brome	1	263	239	91	163	367	225
	2	323	317	98	323	352	109
	3	——‡	——‡	——‡	——‡	——‡	——‡
Ave.		293	278	95	243	359	148
Big bluegrass	1	28	66	236	18	54	300
	2	258	534	207	274	449	164
	3	113	191	169	113	156	138
Ave.		133	264	198	135	220	163

* Stands established in 1942, years 1-3 indicate yields obtained from 1943-1945.
† Yields of solid stands taken as 100.
‡ Mountain bromegrass, P-3368, is susceptible to mite damage, seed crop in third year a failure.

formance with the moderate rate of 10 pounds of seed per acre. Meadow fescue survived only for 3 years, even the third year's stand was greatly reduced. This accounts for the low yields during that year.

Nitrogen Fertilization

Response of Grasses to Nitrogen

Grasses have a high nitrogen requirement. The availability of soil nitrates, especially during early spring, stimulates vegetative growth and the production of fertile culms. This is illustrated in Figures 4 and 5, showing how nitrogen fertilization resulted in increased plant height and increased production of fertile culms on both solid and row stands. The direct effects of nitrogen fertilization on seed yields for the two methods of culture are given graphically in Figure 3.

Table 10 gives the direct effect of nitrogen fertilization on the hay and seed yields of four grasses grown in solid and row stands. The fertilizer was applied at the rate of 30 pounds of nitrogen per

Table 8.—Effect of rate of seeding in pounds per acre on the seed yields of four grasses established in 1936, for the 4-year period of 1937 to 1940, inclusive, Field 8, University Farm.

Crop	Rate of seeding	Seed yields in pounds 1937	1938	1939	1940	Average	Percent of average yield
Smooth brome	4	957	792	330	243	581	115.5
	8	1,052	588	365	161	542	107.8
	12	908	624	351	136	505	100.4
	16	953	462	268	99	446	88.7
	20	838	546	244	132	440	87.5
Ave		942	602	312	154	503	......
Orchard grass	4	120	633	128	190	268	113.6
	6	99	459	145	245	237	100.4
	8	111	470	132	200	228	96.6
	10	103	437	128	206	219	92.8
	12	95	446	145	217	227	96.2
Ave.		106	489	136	212	236	......
Crested wheat	4	627	951	310	256	536	89.5
	6	776	979	381	215	588	98.2
	8	710	949	305	243	552	92.2
	10	990	990	365	301	662	110.5
	12	809	1,111	380	341	660	110.2
Ave.		782	996	348	271	599	......
Meadow fescue	6	462	666	55	......*	394	96.8
	8	524	624	43	......*	397	97.5
	10	524	748	79	......*	450	110.6
	12	491	657	115	......*	421	103.4
	14	479	550	81	......*	370	90.9
Ave.		496	649	75	......*	407	......

* Plants dead; average yields reported for meadow fescue are only for 3 years.

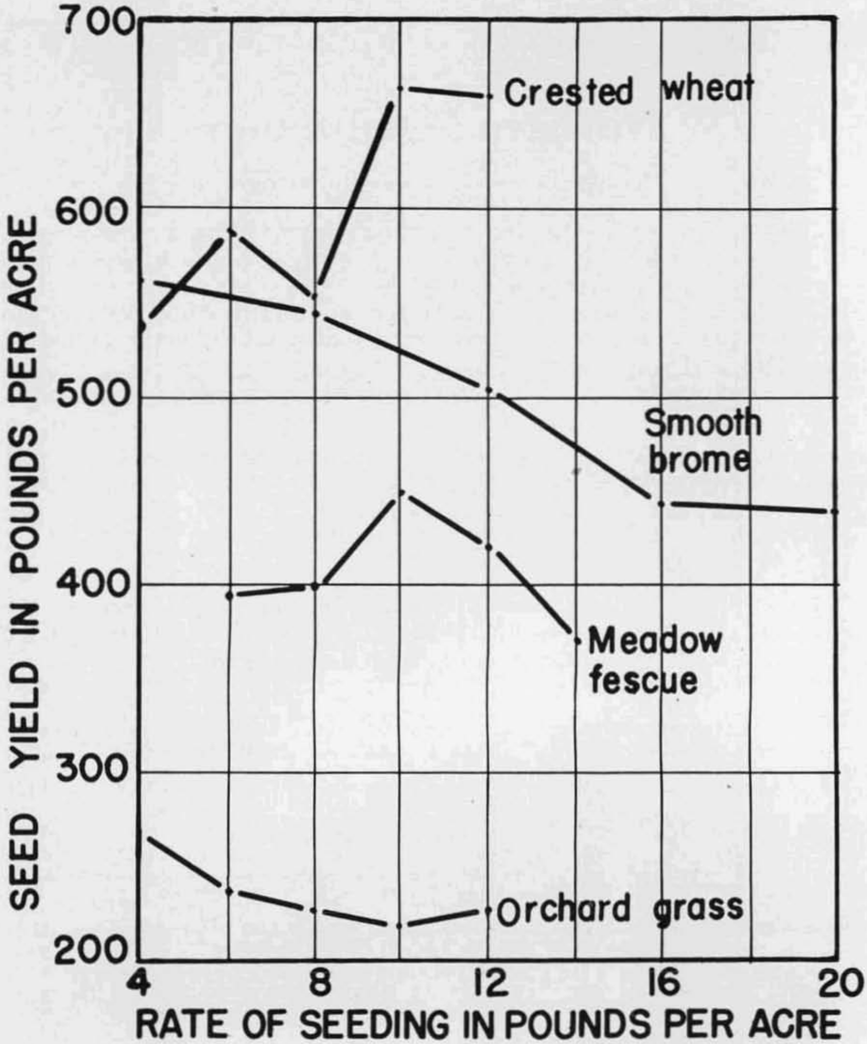

Figure 6. Four-year average seed yields of crested wheat, smooth brome and orchard grass, and 3-year average yields of meadow fescue with different rates of seeding, Field 8, University farm.

acre. The data presented in Table 10 were obtained on a field with a high level of fertility. Significant increases in yields were obtained with both methods of culture. The addition of nitrogen had a more consistent effect on seed production than on hay production. The data presented here shows that nitrogen fertilization is profitable even on fields with a high native level of fertility.

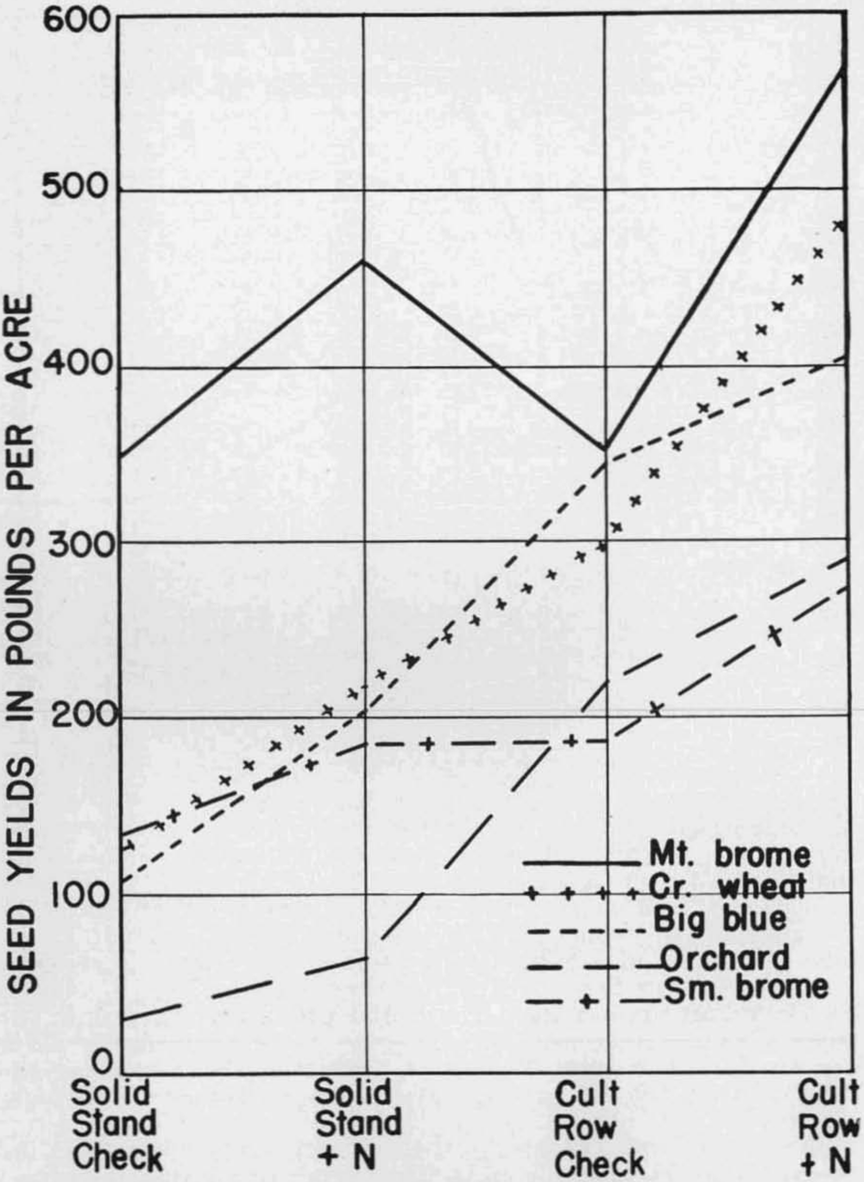

Figure 7. Seed production of mountain brome, crested wheat, big bluegrass, orchard grass and smooth brome in solid and cultivated row stands without and with the annual application of 30 pounds of nitrogen as ammonium sulphate per acre. The yields represent averages for 5 consecutive crop years on a soil of moderate fertility.

Table 9.—Effect of rate of seeding in pounds per acre on the hay yields of four grasses, established in 1936 for the 4-year period of 1937 to 1940, inclusive, Field 8, University Farm.

Crop	Rate of seeding	Hay yields in tons per acre 1937	1938	1939	1940	Average	Percent of average yield
Smooth brome	4	2.50	1.98	1.22	0.69	1.60	98.2
	8	2.48	2.06	1.45	0.58	1.64	100.6
	12	2.98	1.93	1.20	0.45	1.64	100.6
	16	2.94	2.12	1.00	0.43	1.62	99.4
	20	3.02	2.06	1.02	0.51	1.65	101.2
Ave.		2.78	2.03	1.18	0.53	1.63	....
Orchard grass	4	0.64	2.15	1.01	1.02	1.21	98.4
	6	0.67	2.28	1.02	1.16	1.28	104.1
	8	0.72	2.26	0.95	1.11	1.26	102.4
	10	0.78	2.30	0.67	0.99	1.19	96.7
	12	0.67	2.17	0.79	1.25	1.22	99.2
Ave		0.70	2.23	0.89	1.11	1.23	....
Crested wheat	4	2.15	2.15	1.66	1.29	1.81	96.8
	6	2.28	2.23	1.93	1.20	1.91	102.1
	8	2.21	2.15	1.53	0.83	1.68	89.8
	10	2.15	2.09	1.63	1.82	1.92	102.7
	12	2.48	2.12	1.70	1.73	2.01	107.5
Ave.		2.25	2.15	1.69	1.37	1.87	....
Meadow fescue	6	0.82	1.34	0.45	......*	0.87	84.5
	8	0.87	1.79	0.45	......*	1.04	101.0
	10	0.87	1.78	0.69	......*	1.11	107.8
	12	0.83	1.77	0.72	......*	1.11	107.8
	14	0.80	1.71	0.58	......*	1.03	100.0
Ave.		0.84	1.68	0.58	......*	1.03	....

* Plants dead; averages for meadow fescue for 3 years only.

The need for additional nitrogen increases with the age of stands. Maximum yields will not be obtained during the second, third, and fourth year of crop production unless the plants are stimulated by additional nitrogen fertilization. See Figure 3.

Tables 11 and 12 show the effects of nitrogen fertilization on the hay and seed yields of five grasses grown over a period of 5 years in solid stands and in cultivated rows on a field of only a moderate level of fertility. The nitrogen fertilizer was applied annually at 30 pounds per acre in the form of 150 pounds of ammonium sulphate. Special attention should be given to the response of these grasses during the first 2 years of production. Both the hay and seed yields of all the grasses tested were increased by nitrogen fertilization.

Figure 7 shows graphically the 5-year average yields obtained on the field of moderate fertility. This figure shows that the lowest yields were in all cases obtained from the solid stands without fertilization. All five grasses showed increases in yields due to fertilization on solid as well as in cultivated row stands. The combination of row culture and annual nitrogen fertilization resulted in all instances in the highest yields. It is interesting to note that the average yields of the fertilized solid stands were—with the excep-

Table 10.—The effect of nitrogen fertilization, applied as 150 pounds of ammonium sulphate per acre, on the hay and seed yields of grasses grown in solid and row stands, Field 8, University Farm, in 1939 and 1940. Hay yields are given in tons, seed yields in pounds per acre.

Method of culture and grass	Hay yields			Seed yields		
	Check	Plus N.	Percent of check	Check	Plus N.	Percent of check
	1939 results—third crop year					
Solid stands						
Crested wheat	1.46	1.92	132	276	420	152
Smooth brome	0.87	1.78	205	267	444	166
Orchard grass	0.77	1.06	138	155	197	127
Cultivated rows						
Crested wheat	1.80	1.83	102	236	372	158
Smooth brome	1.42	1.72	121	262	315	120
Orchard grass	1.58	1.13	72	223	298	134
Tall meadow oat	1.33	1.78	134	127	179	141
	1940 results—fourth crop year					
Solid stands						
Crested wheat	1.27	1.98	156	245	446	182
Smooth brome	0.35	1.25	357	161	281	175
Cultivated rows						
Crested wheat	1.65	2.05	124	352	570	162
Smooth brome	0.61	0.66	108	108	160	148
Orchard grass	1.18	1.33	113	167	209	125

tion of mountain brome—lower than those obtained from the cultivated row plantings to which no fertilizer was applied. In the case of mountain brome, the solid stands receiving nitrogen yielded more than the cultivated rows not receiving nitrogen. The application of nitrogen to solid stands of grasses while increasing yields does not put these stands on par with grasses grown in cultivated rows even without such fertilization. Nevertheless, this relationship is important in that it shows that application of nitrogen fertilizers to solid stands compensate, at least in part, for the favorable effects obtained from row culture.

The data presented show conclusively that grass seed production demands the presence of an abundant supply of available nitrates. Since favorable responses were obtained on both lands of high and moderate levels of fertility, the above statement can be emphasized by the conclusion that economical grass seed production is highly dependent on nitrogen fertilization. The increases in yields due to fertilization are so pronounced that prospective growers of grass seed cannot afford to pass up this means towards the attainment of greater returns. This is especially the case when soils of only moderate fertility are available or when the crop is to be grown in solid stands rather than in cultivated rows. On soils of high fertility levels nitrogen fertilization may not be necessary for the growth of the first seed crop. The high yields of hay and seed reported in Table 3 for the years of 1937 and 1938, on plots estab-

Table 11.—The effect of nitrogen fertilization, applied annually as 150 pounds of ammonium sulphate per acre, on the hay and seed yields of five grasses grown over a period of 5 years in solid stands, Field 5, University Farm. Hay yields are given in tons, seed yields in pounds per acre.

Grass	Years*	Hay yields: Check	Hay yields: Plus N	Hay yields: Percent of check	Seed yields: Check	Seed yields: Plus N	Seed yields: Percent of check
Mountain brome	1	2.48	3.18	128	743	855	115
	2	1.08	1.26	117	614	624	102
	3	.76	2.01	264	242	534	221
	4	.38	.66	174	117	164	140
	5	.16	.41	256	41	121	295
Ave.		.97	1.50	155	351	460	131
Big bluegrass	1	1.03	1.86	181	289	572	198
	2	.49	1.33	271	122	339	278
	3	.84	1.58	188	81	69	85
	4	.23	.50	217	31	22	71
	5	.18	.43	239	14	28	200
Ave.		.55	1.14	207	107	206	193
Orchard grass	1	.62	1.09	176	91	160	176
	2	.10	.36	360	10	34	340
	3	.24	.81	338	16	34	213
	4	.05	.21	420	3	10	333
	5	.28	.45	161	33	77	233
Ave.		.26	.58	233	31	63	203
Smooth brome	1	1.79	3.19	178	407	517	127
	2	.70	.98	140	141	248	176
	3	.54	1.49	276	50	65	130
	4	.39	.59	161	37	37	100
	5	.23	.45	196	41	58	141
Ave.		.73	1.34	184	135	185	137
Crested wheat	1	1.31	1.71	131	322	473	147
	2	.55	.94	171	100	286	286
	3	.41	.92	224	138	184	133
	4	.37	.68	184	20	29	145
	5	.45	.87	193	52	118	227
Ave.		.62	1.02	165	126	218	173

* Stands established in 1942, years 1-5 indicate yield obtained from 1943-1947.

lished in 1936, were obtained without the additions of nitrogen. However, hay and seed yields in Table 10 show marked responses to nitrogen fertilization made by grasses grown on fertile soils during their third and four year of seed production. Tables 11 and 12 show that very significant increases in both hay and seed yields resulted from nitrogen fertilization in the first and even greater increases in following crop years.

Rate of Nitrogen Fertilization

In the previous experiments reported, only one rate of nitrogen application was considered—30 pounds per acre. Table 13 shows that under conditions prevailing at Aberdeen, where mountain brome grass was grown in rows under irrigation, increases in yields of both hay and seed were obtained with increasing applications of nitrogen in the form of ammonium sulphate. The highest

Table 12.—The effect of nitrogen fertilization, applied annually as 150 pounds of ammonium sulphate per acre, on the hay and seed yields of five grasses grown over a period of 5 years in cultivated rows, Field 5, University Farm. Hay yields are given in tons, seed yields in pounds per acre.

		Hay yields			Seed yields		
Grass	Years*	Check	Plus N	Percent of check	Check	Plus N	Percent of check
Mountain brome	1	2.93	3.07	105	679	902	133
	2	.91	1.39	153	285	502	176
	3	.99	1.94	196	396	781	197
	4	.89	1.44	162	249	356	143
	5	.39	.71	182	162	311	192
Ave.		1.22	1.71	140	354	570	161
Big bluegrass	1	1.60	1.65	103	622	726	117
	2	2.06	2.39	116	728	743	102
	3	1.65	1.97	119	39	43	110
	4	1.10	1.55	141	162	249	154
	5	.94	1.39	148	195	264	135
Ave.		1.47	1.79	122	349	405	116
Orchard grass	1	2.60	2.82	108	550	616	112
	2	1.13	1.68	149	218	337	165
	3	.76	1.30	171	79	113	143
	4	.75	1.50	200	155	255	165
	5	.43	.62	144	96	146	152
Ave.		1.13	1.58	140	220	293	133
Smooth brome	1	3.71	4.05	109	558	754	135
	2	1.27	1.46	115	175	261	149
	3	.50	1.00	200	38	62	163
	4	.62	1.22	197	74	147	199
	5	.39	.76	195	83	149	180
Ave.		1.30	1.70	131	186	275	148
Crested wheat	1	2.41	3.51	146	781	883	113
	2	1.40	2.06	147	285	504	177
	3	.86	1.36	158	229	395	172
	4	.79	1.44	182	92	190	207
	5	.71	1.94	273	102	440	431
Ave.		1.23	2.06	167	298	482	172

* Stands established in 1942, years 1-5 indicate yield obtained from 1943-1947.

average hay yields were produced when 90 pounds of nitrogen were used. Maximum seed yields were obtained with the use of 76-90 pounds. Figure 8 gives a graphic presentation of the seed yields of mountain brome grass with increasing amounts of nitrogen applied.

The field at the Aberdeen Branch Station on which the above experiment was conducted was of a relatively high fertility level. It was cropped with alfalfa for several years prior to being plowed out in 1939. Potatoes were produced in 1940. A seeding of Bromar mountain brome grass was established in May of 1941. The first seed crop, averaging 1100 pounds per acre, was harvested in 1942. No fertilizer was used in the production of this crop. The yields reported in Table 13 are from the second, third, and fourth crop years. Ammonium sulphate was applied by broadcasting in the spring of each year prior to the time the grass broke dormancy.

Table 13.—Hay and seed yields of mountain bromegrass grown in rows under irrigation for 4 years at the Aberdeen Branch Station receiving different rates of nitrogen applications during the second, third, and fourth year of production. No nitrogen fertilizer was applied during the first year of production.

Average yearly applications of nitrogen in pounds per acre	Year of crop production 2	3	4	4 year average	Yields in percent of check
	Hay production in tons per acre				
0	0.60	0.82	0.78	0.73	100
20	0.54	1.12	1.00	0.89	122
37	0.72	1.37	1.23	1.11	152
54	0.82	1.25	1.30	1.12	153
76	0.90	1.65	1.59	1.38	189
90	0.92	1.81	1.81	1.51	207
Ave. by years	0.75	1.34	1.28	1.12	-----
	Seed yields in pounds per acre				
0	4.14	337	278	343	100
20	427	438	340	402	117
37	555	519	378	484	141
54	614	468	435	506	148
76	701	621	565	629	183
90	643	664	531	613	179
Ave. by years	559	508	421	596	-----

The field is classified under land use capability I. The soil type is Declo loam.

The amounts of nitrogen to be applied to grasses for the realization of maximum economic returns depends on the availability of moisture during the growing season, the levels of fertility of the soils used, and on the age of the stand.

Grass plants can use larger amounts of nitrogen when grown under conditions of abundance of moisture, as under irrigation, than when grown under dryland conditions. Under dry conditions 20 pounds of nitrogen per acre (100 pounds of ammonium sulphate or 60 pounds of ammonium nitrate) is usually sufficient. In the northern part of the state under 20 or more inches of rainfall these rates can be increased to 50 pounds of nitrogen per acre (250 pounds of ammonium sulphate or 150 pounds of ammonium nitrate). As high as 90 pounds of nitrogen per acre (450 pounds of ammonium sulphate or 275 pounds of ammonium nitrate) can be used to advantage in the irrigated parts of the state.

A smaller response to nitrogen fertilization may be expected on soils of high than on those of low levels of fertility.

Hay and seed yields of grasses decrease with age of stands. As stands become older the response to nitrogen increases. On fertile soils good seed yields can be produced without nitrogen fertilization during the first crop year. After that, the response to nitrogen fertilization becomes so pronounced that growers cannot afford to pass up this opportunity to produce increased yields.

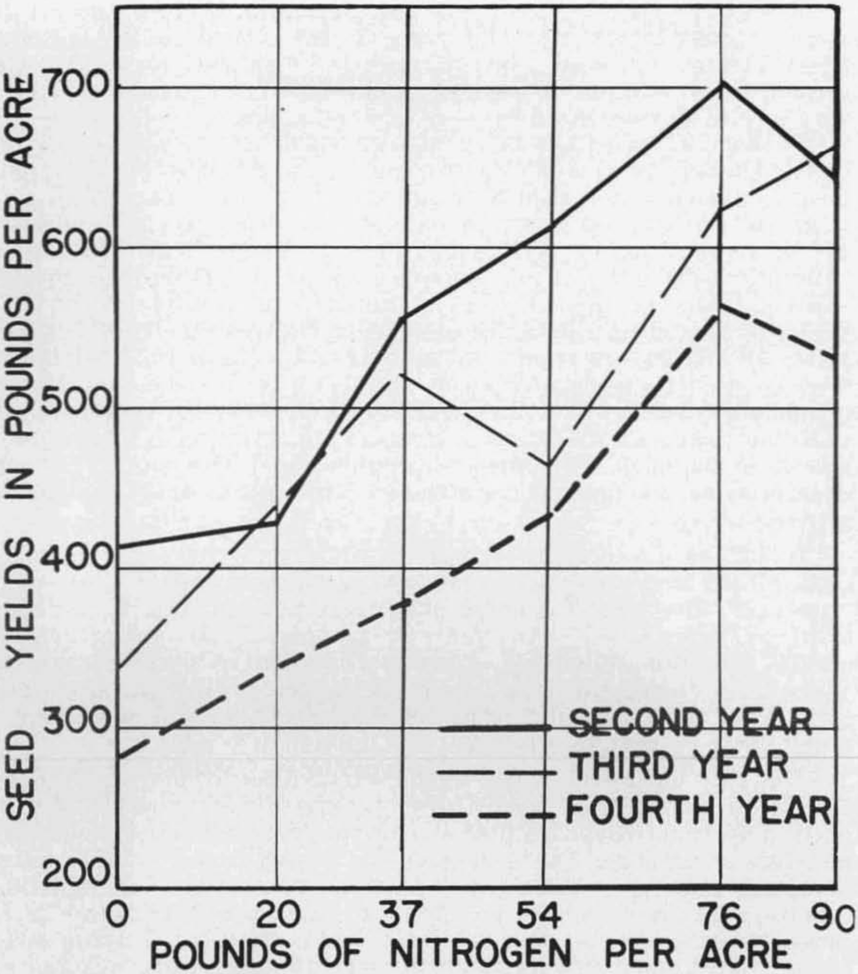

Figure 8. Seed yields of Bromar mountain bromegrass with increasing applications of nitrogen. Results from Aberdeen Branch Station, 1943, 1944 and 1945.

This is the case especially in the irrigated areas of the state where water is available to support a vigorous growth. Preliminary tests also indicate that nitrogen fertilization not only increases seed yields but also results in improved quality of the seed produced. In addition to this, grasses grown under conditions of an abundant supply of available nitrogen do a more effective job in soil improvement than those produced under nitrogen starvation. This results in higher yields of crops following fertilized grasses in the course of the rotation.

Adaptation and Performance of Various Grasses

Tables 14-20 give the hay and seed yields of the grasses tested on the University farm at Moscow and at the Aberdeen and Tetonia branch stations. The yield data presented in tables 14 and 15 give the results of grasses grown in solid stands at Moscow. The grasses in the strain nursery at Moscow were grown in 3-foot cultivated rows, table 16. The yields reported from the Aberdeen branch station, tables 17 and 18, were obtained from row plantings with the rows spaced at a distance of 2 feet. The results from Tetonia, tables 19 and 20, are from solid seedings. No commercial fertilizers were used on the tests at Moscow and Tetonia. The soils used were of moderate levels of fertility. Yield data previously reported show that the yields of the grasses tested at Moscow could have been increased materially by nitrogen applications. The plots at Aberdeen received annually a maintenance application of 40 pounds of nitrogen.

It will be observed that both the hay and the seed yields of most all the grasses tested decreased significantly after the second crop year. The yield tests extended over periods of 2 to 4 years. While averages based on the years of the special tests are presented, special attention should be given to the relative performances of the grasses during the first 2 years of the tests. The special characteristics of the grasses listed in the tabulated data will be discussed under their respective headings.

The grasses were tested at Moscow, Aberdeen, and Tetonia. Climatic conditions at these three stations differ widely and give good indications of the adaptability of the tested grasses to varying moisture conditions. The grasses were grown under conditions of abundant moisture on irrigated plots at Aberdeen. The moisture conditions at Moscow, with an annual average precipitation of 21.75 inches, are designated as moderate; while those at Tetonia with an average annual precipitation of only 13 inches are designated as fairly dry. The seasonal distribution of moisture at the different locations also influenced the yields of the grasses tested. At Aberdeen, moisture was made available throughout the entire growing season. At Moscow and Tetonia summer droughts are the rule and are characteristic features of the climates of these two areas.

Table 21 gives the common and scientific names of the grasses grown in the trial plots.

The Wheatgrasses (Agropyron species)

The wheatgrasses are used widely in the western states because of their hardiness, drought-resistance, and their wide range of adaptation to climatic and soil conditions. Both sod-forming and bunch-types are found. The main reasons for the extensive employment of the wheatgrasses in the re-vegetation of depleted range and abandoned crop lands are fair to good seed production, rapid germination of seed during periods when moisture is available, and the ability to produce vigorous seedlings not readily damaged by drought. The wheatgrasses grow rapidly in spring. This enables them to compete with rapidly growing legumes and makes them of value in alfalfa-grass and sweet clover-grass mixtures.

Crested Wheatgrass is a long-lived bunchgrass introduced from Russian Turkestan. It has extensive, deeply penetrating roots. This, together with its ability to start growth early in spring and to reduce its growth during hot, dry periods in summer, makes the plant one of the most valuable grasses for desert conditions. The ability of crested wheatgrass seedlings to resist drought adds to the adaptation of this grass to dry areas. Stands are easily established. However, under desert conditions stands must be protected against grazing for a number of years to insure establishment and survival.

In relatively moist areas, such as at Moscow, intermediate wheatgrass produced higher forage yields than crested wheat, Table 14.

Crested wheatgrass is an excellent seed producer, and seed crops are easily handled. Good seed yields run from 400 to 500 pounds per acre during the first 2 years of production; in dry areas seed yields of 200 pounds per acre are common.

Two types of crested wheatgrass were tested: the standard or tall growing, and the fairway type. The standard type is the better producer of both forage and seed. Seed of the standard type is in greatest demand.

Siberian Wheatgrass is a recent introduction from Russia and Siberia. It resembles crested wheatgrass in its growth habits. The heads are narrower and do not have the short beards found on crested wheatgrass. Siberian wheatgrass is adapted to sandy soils in dry areas where it may be used in pastures and in hay mixtures. Table 16 shows that it produced less hay and seed at Moscow than crested wheatgrass.

Bluebunch wheatgrass is a native drought-resistant, long-lived bunchgrass occurring chiefly in the dry open areas of the western states. It is one of the most important species of the native grasslands of the Pacific Northwest and intermountain sections. Bluebunch wheatgrass does well on many types of dry soil, but reaches its best development on well-drained sandy loams. Its main use is as a range plant. Like crested wheatgrass it can also be used to advantage in the re-vegetation of abandoned crop land. It produces an abundance of palatable forage which is best grazed in late spring to mid-summer. Early spring grazing interferes with seed production. Such seed production is necessary for the preservation of good stands.

Two species of bluebunch wheatgrass occur—the bearded (Agropyron spicatum) which is the more common, and the beardless type (A. inerme). In the tabulated yield data acc. No. P-737 is the bearded while Whitmar is the beardless type.

or for general pasture use. Bromegrass demands fairly fertile soils. One of its faults is that it becomes sod-bound, especially when grown on poor, heavy soils.

Smooth brome is used more widely in Idaho than any other cultivated grass. It is easily established. Its aggressiveness, rapid rate of growth, long season of growth, and palatability make it an excellent grass for pastures and hay mixtures in both the moderate rainfall and irrigated sections. Smooth brome is not so drought-resistant as crested wheatgrass and for this reason has no place on drier ranges. However, it produces more and a better quality of forage in the moderate moisture areas than can be obtained from crested wheatgrass.

Smooth brome is a good seed producer and is easily handled as a seed crop. Seed yields as high as 842 pounds per acre have been recorded at Moscow, Table 3. However, yields of from 300 to 400 pounds per acre are more common, Table 15. A yield of 1205 pounds per acre is on record under irrigation at Aberdeen, Table 18. Even under the dry conditions at Tetonia the average for the first 2 years of seed production was 327 pounds per acre, Table 20. The straw of smooth brome is green in color, leafy, soft, and has a high feeding value.

The Manchar strain is recommended.* This strain is a selection from an introduction from Manchuria. Strong seedling vigor is characteristic of Manchar smooth brome and its slow sod-forming habit makes it less subject to the development of an undesirable sod-bound condition. Other characteristics are its leaves attached high on the stems, a dark purple color, heavy seed threshing relatively free from the glumes, and above all by good forage and seed production. The Manchar strain has given consistently higher yields of both forage and seed than the commercial strains tested at Moscow and Aberdeen, Tables 14-18. A naturalized strain, from Kansas P-3197, produced good forage yields but less seed than Manchar at Moscow, Table 16.

Erect brome was tested only at Tetonia, where it produced less forage than smooth brome, Table 19. It was noticeably shorter-lived than smooth brome. Erect brome is a slightly pubescent bunchgrass introduced from Europe. Aside from the fact that it does not increase by underground rootstocks, its general growth habits resemble those of smooth brome. In Europe it occurs on dry, exposed situations and on soils rich in lime. So far no special use has been found for this grass in Idaho.

Mountain brome is a rapidly developing short-lived upright-growing, non-sod-forming, perennial grass native to the Rocky Mountain and Pacific coast areas. It occurs in scattered bunches, often on rather depleted soils. The rapid spring growth of this grass favors its used in sweet clover-grass and alfalfa-grass mixtures. In the first combination mountain brome is used either in short term pastures or as a soil improvement crop. Although moun-

* Stark, R.H., and Klages, K.H.W., Manchar smooth brome. Idaho Agr. Exp. Sta. Bull. No. 275, 1949.

tain brome is leafy, it produces rather coarse, harsh stems. For this reason, and because of its shorter life in most locations, it is not so desirable in alfalfa-grass mixtures as the finer-stemmed, longer-lived smooth brome. Sweet clover-mountain brome combinations produce excellent green manure crops.

Mountain brome is an excellent seed producer. The seed is large and heavy and therefore easy to handle. However, the seed shatters readily when ripe, and it is necessary to time properly the harvesting operations to avoid loss from shattering. The large seeds, combined with rapid germination and production of vigorous seedlings, make it possible to establish stands of this grass on rather dry sites. As high as 1,463 pounds of seed per acre have been harvested at Moscow, Table 15. Excellent seed yields were also obtained under irrigation. The 4-year average yield at Aberdeen was 785 pounds per acre, Table 18.

The Bromar strain is recommended. It comes from a selection out of native stands in eastern Washington. Bromar mountain brome is smut resistant, large seeded, vigorous, leafy, and late in maturity.

The Fescues (Festuca species)

The fescue group contains a large number of diverse types with reference to growth characteristics, adaptation, and use. They are native in the temperate or cool zones. The broad-leafed, tall-growing types are used in hay mixtures and in pastures; the fine-leafed and dwarf types are used in lawns, pastures, and for erosion control.

Meadow fescue is a fairly tall, broad-leafed, palatable, perennial grass introduced from Europe. It is adapted to temperate areas with moderate amounts of moisture. Meadow fescue is one of the most widely grown grasses in northwestern Europe where it is commonly known as English bluegrass. The fairly high moisture requirements of meadow fescue are evident from its comparative performance at Moscow and Aberdeen. It is rather short-lived under the summer drought conditions at Moscow. Stands thinned out rapidly and forage as well as seed yields decreased materially after the first 2 years of production, Table 3. At Aberdeen, where the crop was supplied an abundance of moisture by irrigation, meadow fescue stands were well maintained and excellent forage and seed yields were produced over the 4-year period of the test, Tables 17 and 18.

Meadow fescue has been used extensively in irrigated pasture mixtures throughout the southern part of the state. However, it is yielding its place to the generally more productive tall fescue. Tall fescue has the advantage in that it has a more rapid recovery rate after grazing. Meadow fescue production should be restricted to areas well supplied with moisture.

Meadow fescue is an excellent seed producer in Idaho's irrigated areas. The seed is heavy, weighing from 23 to 27 pounds per bushel, and the crop is easily handled for seed production. The 4-year average seed yield at Aberdeen was 586 pounds per acre.

Tall fescue is a deep rooted, strongly tufted, erect, long-lived perennial. It is more drought resistant and longer-lived than meadow fescue. It can, for these reasons, be used to advantage in northern Idaho pasture and hay mixtures. The forage and seed yield advantages of tall over meadow fescue in the Moscow tests, Table 16, are largely accounted for by its greater drought-resistance. Other characteristics making tall fescue a good pasture grass are its rapid regrowth after grazing, the tendency of its leaves to remain green until late in the season, and its ability to maintain growth on irrigated land during hot weather.

Tall fescue has a wider range of soil adaptation than meadow fescue. Both grasses prefer heavy soils well supplied with organic matter. However, tall fescue will grow better on wet soils than meadow fescue, and, largely due to its more extensive root system, it will also survive on soils that are too dry for meadow fescue. Alta fescue is more tolerant to soil alkalies than many other grasses.

Tall fescue is coarser and produces a taller growth than meadow fescue. The grass has been criticized for low palatability. Observations and tests have shown that tall fescue grass is readily eaten by all kinds of livestock in well managed pastures. Tall fescue is an excellent pasture grass for the irrigated and moderate moisture areas of the state. It is also an excellent grass for moist bottom lands. Like meadow fescue it is a good seed producer and seed crops are easily handled. Close attention must be given to the crop as the seed approaches maturity so that shattering losses due to overripeness may be avoided.

The Alta strain of tall fescue is recommended. This selection was made in Oregon. Kentucky 31 and Goars fescue are similar to Alta fescue.

Reed fescue is a larger and coarser grass than tall fescue. It is native to Europe, north Africa, and Siberia. Reed fescue produced less forage and seed than tall fescue at Moscow, Table 16. The forage produced by reed fescue lacks palatability.

Red fescue is a low-growing, fine-leafed, creeping, long-lived perennial. It is a native of North America and Europe where it is adapted to the moist and moderate rainfall areas.

Red fescue is used especially in lawns. It produces an excellent turf, and is especially adapted to shady sites. Since the leaves of this grass are somewhat tough, red fescue lawns are not so easily clipped as bluegrass lawns. Red fescue is not so agressive as Kentucky bluegrass. This is an advantage in that less effort is required to keep it confined to areas where it is desired. Red fescue will not invade borders and flower beds so readily as Kentucky bluegrass.

The forage production of red fescue is low when compared to that of the taller fescues. Red fescue has a place in pasture mixtures in the moderate moisture areas to provide ground cover on the drier sites of such pastures. It also has a place in certain alfalfa-grass mixtures, especially when only a small percentage of grass is desired in the hay, and where the beneficial soil effects of a legume-grass mixture are demanded. The surface growth of red and other fine-leafed fescues provide the desired ground cover in alfalfa-grass mixtures, and the large number of fine roots produced by these grasses exert a favorable influence on soil structure.

Red fescue is a good seed producer. Seed yield tabulations show significant differences in the performance of the various strains. Thus, the Danish strain averaged 313 pounds of seed per acre at Moscow, as compared to only 163 pounds for the British strain tested, Table 15. Individual plants of red fescue show variations in their ability to reproduce vegetatively. The attempt to distinguish between strains on the basis of this characteristic may account for the use of the common name "creeping red fescue."

Chewings fescue is similar to red fescue in its general characteristics. It differs from red fescue in that it is tufted and does not creep. Chewings fescue is used for lawns and to a limited extent in pastures. It does not produce so good as turf as red fescue.

Sheep fescue is a native drought-resistant bunchgrass of medium height, with numerous, rather stiff, folded, bluish-gray basal leaves. It provides excellent ground cover and root growth. It is used in dryland pastures, in alfalfa-grass mixtures in dry areas, and as a dryland lawn grass. While sheep fescue does not produce so much forage as the taller broad-leafed fescues on good soils and under favorable moisture conditions, it succeeds better than most pasture grasses on dry, sandy, or gravelly soils.

Two strains of sheep fescue were tested—hard fescue, P-2517, and the sulcate, P-274. The first is the taller growing type. It can be used with alfalfa on low fertility soils where erosion control is essential. The second is a short, highly drought-resistant strain for dryland range and pasture mixtures, dryland lawns, and dryland gully protection.

Like the other fine-leafed fescues, sheep fescue is easily handled as a seed crop. Yield tabulations show that it is one of the better seed producers of the group.

Idaho fescue is one of the most widely distributed, native, fine-leafed, tufted fescues in the western states. It is commonly associated with wheatgrass. Idaho fescue should be regarded as one of the more valuable range grasses. It withstands close grazing and trampling. Under cultivation it is a low producer of forage and seed. Tables 14 and 15.

The Bluegrasses (Poa species)

Approximately 200 species of Poa are distributed, primarily in the temperature and cooler areas. They are used for lawns, pasture, and hay.

Kentucky bluegrass occurs as a native over the moist areas of Europe and Asia. It is now widely distributed over the temperate, humid areas of the United States. Original distributions of the grass were expedited by its agressiveness. It reproduces by seed and rhizomes. The dense sod produced by this grass and the dark green color of the foliage make it ideal for lawns and turfs; it is used more for these purposes than any other grass in the northern part of the United States.

The sod produced by Kentucky blue is resistant to trampling. This and its aggressiveness are desirable in a pasture grass. However, this very trait of the grass frequently results in the crowding out of more desirable and higher producing species in both pastures and meadows. For this reason most Idaho pastures, except at high elevations where cool summer temperatures prevail, could be improved if Kentucky bluegrass could be eliminated. The grass is found as an invader in practically all the irrigated pastures of Idaho where it becomes increasingly abundant with the age of the pasture. The greatest weakness of Kentucky bluegrass is that it languishes during periods of summer heat. Where species capable of making good growth during the heat of the summer, such as orchard grass, smooth brome, and tall fescue, are crowded out by the aggressive Kentucky bluegrass, the carrying capacities of such pastures are reduced.

The forage and seed yields of Kentucky bluegrass are fairly low. Seed yields drop off rapidly after the first crop year.

Canada bluegrass has the same general characteristics as Kentucky blue. Botanically it differs from Kentucky bluegrass by its blue-green foliage, its distinctly flattened stems, and its shorter contracted panicle. The two grasses are used for the same purposes. Canada bluegrass is somewhat more resistant to summer heat and drought, and will grow on poorer soils. In parts of northern Idaho, Canada bluegrass should be classified as a weedy grass.

At Moscow commercial strains of Canada and Kentucky bluegrass produced comparably forage yields. However, Canada bluegrass produced higher and more consistent yields of seed, Tables 14 and 15. Canada bluegrass strain P-410 was distinctly superior to the commercial strain both in forage and seed yields. Under irrigation at Aberdeen strain P-410 yielded less forage than the commercial type, but was greatly superior to it in seed production. The first year's seed yield was 1,390 pounds per acre, Table 18.

Big Bluegrass is a robust bunchgrass native to the western states. It produces an abundance of pale green basal leaves. The grass is outstanding for its early spring growth, being earlier than crested wheatgrass. It has an extensive root system and is drought-resistant. These characteristics make the grass desirable in dryland alfalfa-grass mixtures when grazed in moderation. It is also a good range grass in areas with more than 15 inches of rainfall. The fact that it makes such an early spring growth partly accounts for its present absence from most range areas. Premature and heavy continuous grazing and trampling are injurious to stands. Big bluegrass demands a firm seedbed and shallow seeding for the establishment of good stands.

Tests at Moscow, Aberdeen, and Tetonia show big bluegrass to be a good producer of forage and seed. The seed crop of this grass is easily handled. The 3-year average seed yields at Moscow were 318 pounds per acre, and under irrigation at Aberdeen 452 pounds per acre. The Sherman strain, P-2716, is recommended.

The Wild-rye Grasses (Elymus species)

Many species of wild ryegrass are native to the western states. Most of them are coarse bunchgrasses. Some imported species as the Russian wild ryegrass (**E. junceus**) are now being tested. The wild ryegrasses have coarse, rough, and relatively unpalatable foliage. These grasses make an early spring growth and at that time of the year provide some usable forage. Their main use is for re-vegetation and soil holding. Most of the wild ryegrasses are tolerant to soil alkalies. The wild ryegrasses should not be confused with ryegrass, species of Lolium.

Canada wild-rye is a widely distributed tall growing, coarse, perennial bunchgrass. It occurs on a great variety of soils and because of its rapid growth provides excellent ground cover. Canada wild-rye produces a rather unpalatable feed, but it will provide early spring grazing. Heavy spring grazing should be avoided where the production of ground cover is the major objective. Under such use it is one of the first species to disappear. It is tolerant to moderate alkali conditions and restricted drainage.

Canada wild-rye is a good producer of coarse forage and seed. At Moscow the 3-year average seed production was 416 pounds per acre. At Aberdeen it yielded 442 pounds over a 4-year period.

Blue wild-rye is also widely distributed over the western states. It is drought-resistant and shade-tolerant. It is especially abundant on old burns and cut-over areas of the Northwest. Blue wild-rye is not so coarse as Canada wild-rye and is therefore more readily eaten by livestock. Most of the grazing value from the species is derived in early spring before the grass becomes too tough. As with Canada wild-rye, blue wild-rye stands are easily established. The large seeds produced by the wild-rye grasses enable deep seeding, and the grass provides excellent ground cover soon after seeding.

Blue wild-rye yielded considerably less forage than Canada wild-rye both at Moscow and under irrigation at Aberdeen. It was not so long-lived as the Canada wild-rye at Tetonia. Seed yields of blue wild-rye were less than those of the Canada wild-rye at Moscow and Tetonia; at Aberdeen they were somewhat higher.

Miscellaneous Grasses

Orchard grass is one of the standard hay and pasture grasses. It has been used extensively since its introduction from Europe in 1760. It is a bunchgrass, starting growth in early spring and growing late into the fall. One of its greatest merits is its ability to produce good growth during summer heat. Orchard grass does best on rich soil but also succeeds on light soils of medium fertility and on moist, heavy land. It is one of the best grasses for shady sites.

All of these charcateristics make orchard grass one of the best hay and pasture grasses. It can be used for these purposes in the moderate rainfall and in the irrigated areas of the state. It competes with smooth brome as a grass in alfalfa mixtures. The main objection to orchard grass in an alfalfa-grass mixtures is that it passes the prime hay cutting stage before the alfalfa is ready. In this respect smooth brome is the more desirable grass. However, the many basal leaves produced by orchard grass add to the value of alfalfa-grass hay.

Orchard grass did not produce so high forage or seed yields as smooth brome at Moscow, Tables 14 and 15, when grown in solid stands. However, its performance compared favorably with that of Manchar smooth brome when the crop was grown in rows, Table 16. The grass was a good producer of forage and seed at Aberdeen. Orchard grass responds favorably to nitrogen fertilization. When the crop is grown for seed both row culture and nitrogen fertilization are necessary. Orchard grass is easy to handle as a seed crop.

Table 16 shows that commercial orchard grass produced about the same yields as the tall Swedish strain. The taller growing strains produced more forage than the dwarf strains.

Tall meadow oatgrass has been known for a long time in European agriculture. It was introduced into the United States early in the 19th Century but has not been used extensively. The main reason for this is the high seed cost. Seed costs are high for two reasons. First, the grass has poor seed habits. An abundance of seed is produced, but harvesting is difficult because of the tendency of the seed to shatter before it is fully matured. The harvested seed is hard to clean. The second reason for high seed costs is the large seed size. Large seed size is desirable since it is closely related to seedling vigor, but it also requires that a greater number of pounds of the grass must be used in a mixture to establish desired densities of stands. The Tualatin strain of tall meadow oat has greatly improved seed habits over commercial strains in that it has the ability to hold its seed longer as the plants approach maturity. The increasing production of this strain should lead to lower seed prices and greater use of tall meadow oatgrass.

Tall meadow oatgrass is used in pastures and can also be used in alfalfa-grass mixtures. It has wide adaptation to drainage conditions, and is fairly drought-resistant. Tall meadow oatgrass is especially adapted to light, sandy, or gravelly land. It is one of the best pasture and hay grasses for such light soils.

Tall meadow oatgrass is a good producer of forage and a fair producer of seed. The 3-year average seed yields at Moscow were 192 pounds per acre when grown in solid stands. The comparison of common and Tualatin tall meadow oatgrass are shown in Table 16. The 2-year average yields of the common were 244 pounds as compared to 408 pounds per acre for the Tualatin. At Aberdeen tall meadow oatgrass produced less forage than Manchar smooth brome. Seed yields were also significantly less than for smooth brome.

Table 14.—Hay yields in tons per acre of grasses established in 1941, for a 3-year period, 1942-1944, inclusive, University farm, Moscow, Field 5.

Grasses and sources	1942	1943	1944	3-year average
Bromegrasses				
Mountain, commercial	1.72	1.45	0.51	1.23
Smooth, Manchar	2.07	1.84	0.64	1.52
Smooth, commercial	1.55	1.46	0.51	1.17
Fecsues				
Alta	1.81	1.72	0.62	1.38
Tall, commercial	1.52	1.76	0.66	1.31
Red, Danish	0.87	1.25	0.43	0.82
Hard, P-2517, S.C.S.	0.97	0.92	0.43	0.77
Chewings, commercial	1.18	0.62	0.26	0.69
Red, British	0.74	0.55	0.09	0.48
Idaho, P-6187, S.C.S.	0.41	0.40	0.35	0.38
Wild-rye grasses				
Canada, P-786, S.C.S.	2.27	2.31	1.06	1.88
Blue, P-2662, S.C.S.	0.70	1.96	0.34	1.00
Wheatgrasses				
Standard crested, commercial	1.72	2.41	0.86	1.66
Slender, Primar	1.21	1.52	0.84	1.19
Beardless, Whitmar	0.58	1.64	0.48	0.90
Bluebunch, P-737, S.C.S.	0.52	1.37	0.64	0.84
Fairway crested selection	1.10	1.22	0.37	0.90
Intermediate, P-2327, S.C.S.	3.09	4.50	1.16	2.82
Thickspike, P-1822, S.C.S.	0.55	1.26	0.86	0.89
Bluegrasses				
Big blue, Sherman	0.84	1.62	0.82	1.09
Canada blue, P-410, S.C.S.	0.32	1.47	0.56	0.78
Canada blue, commercial	0.36	0.54	0.48	0.46
Kentucky blue, commercial	0.45	0.62	0.25	0.44
Miscellaneous grasses				
Redtop, commercial	1.62	1.60	0.42	1.21
Timothy, commercial	1.07	0.96	0.48	0.84
Tall meadow oat, commercial	1.70	1.47	0.90	1.36
Orchard grass, commercial	1.32	0.85	0.38	0.85
Bulbous barley, P-306, S.C.S.	1.42	1.12	0.27	0.94
Reed canary, Sandpoint	3.13	3.55	0.59	2.42
English rye, commercial	0.28	-----	-----	-----

Timothy is the most widely cultivated hay grass used in American agriculture. It should be regarded strictly as a hay rather than as a pasture grass. Timothy survives only for short periods in closely grazed pastures. In Idaho, timothy can be used to advantage in combination with red clover on land that is not drained well enough to enable the production of alfalfa.

Tables 14 and 15 show that timothy was not a particularly good producer of forage and seed at Moscow. At Aberdeen, forage yields compared favorably with other standard grasses and good seed yields were produced. However, it is questionable whether Idaho can compete with the extensive production of seed of timothy in the southern corn belt. Timothy seed is abundant and cheap.

Table 15.—Seed yields in pounds per acre of grasses established in 1941, for a 3-year period, 1942-1944, inclusive, University farm, Moscow, Field 5.

Grasses and sources	Yields by years 1942	1943	1944	3-year average
Bromegrasses				
Mountain, commercial	1,463	741	83	762
Smooth, Manchar	461	315	99	292
Smooth, commercial	281	226	90	199
Fescues				
Alta	717	457	168	447
Tall, commercial	646	349	129	375
Red, Danish	417	331	191	313
Hard, P-2517, S.C.S.	475	251	135	287
Chewings, commercial	652	92	75	273
Red, British	368	65	55	163
Idaho, P-6187, S.C.S.	168	203	92	155
Wild-rye grasses				
Canada, P-786, S.C.S.	494	508	245	416
Blue, P-2662, S.C.S.	106	413	105	208
Wheatgrasses				
Standard crested, commercial	517	480	136	378
Slender, Primar	483	431	211	375
Beardless, Whitmar	80	301	87	156
Bluebunch, P-737 S.C.S.	61	300	67	143
Fairway crested selection	249	145	15	136
Intermediate, P-2327, S.C.S.	212	172	10	134
Thickspike, P-1822, S.C.S.	39	223	138	133
Bluegrasses				
Big blue, Sherman	238	506	210	318
Canada blue, P-410, S.C.S.	262	469	214	315
Canada blue, commercial	193	171	127	164
Kentucky blue, commercial	264	58	11	111
Miscellaneous grasses				
Redtop, commercial	551	423	179	384
Timothy, commercial	303	191	100	198
Tall meadow oat, commercial	253	189	135	192
Orchard grass, commercial	336	131	69	179
Bulbous barley, P-306, S.C.S.	223	187	10	140
Reed canary, Sandpoint	24	53	20	33
English rye, commercial	282	----	----	----

Redtop is another grass that has been used for a long time in American agriculture. It is grown in the same general area as timothy and is especially adapted to wet, acid soils. It has a place in Idaho for the production of both hay and pasture on wet, bottom soils. On such soils it is desirable to use it in combination with alsike clover. Redtop has given excellent results as a grass for the establishment of cover on recent burns in the cut-over areas of the state. The abundant seed production of this grass accounts for its relative aggressiveness. Redtop is especially adapted to wet soils but also has a fair degree of drought-resistance.

Even though redtop is a low growing grass, it produces a dense ground cover. This accounts for the relatively good forage yields

Table 16.—Hay and seed yields in a strain nursery, Field 2, University farm, Moscow. Hay yields in tons, seed yields in pounds per acre.

Grasses and strains	Hay yields 1946	Hay yields 1947	Hay yields 2-yr. ave.	Seed yields 1946	Seed yields 1947	Seed yields 2-yr. ave.
Bromegrasses						
Smooth, Manchar	3.18	2.24	2.71	734	215	474
Smooth, Kansas P-3197	3.50	2.63	3.06	478	255	366
Smooth, commercial	2.75	2.15	2.45	316	202	259
Mountain, commercial	2.92	1.74	2.33	766	941	853
Mountain, Bromar	3.94	1.79	2.86	654	632	643
Mountain, Pubescent, P-3972	3.85	1.79	2.82	660	713	686
Fescues						
Alta	3.72	2.23	2.97	911	309	610
Reed, P-237	2.31	2.73	2.52	225	336	280
Meadow, commercial	2.13	1.27	1.70	644	363	503
Chewings, P-3361	0.85	1.50	1.17	424	498	461
Hard, P-2517	0.50	1.03	0.76	224	565	394
Sheep, sulcate, P-274	0.28	1.28	0.78	134	632	383
Red, Olds, P-8183	1.48	1.88	1.68	706	659	682
Red, German, P-234	1.14	1.68	1.41	571	525	548
Red, Danish	1.15	1.43	1.29	451	538	494
Wheatgrasses						
Slender, Primar	3.56	3.06	3.31	654	686	670
Slender, Mecca	2.62	1.50	2.06	758	605	681
Bearded, P-9115	2.61	3.13	2.87	522	1,022	772
Siberian, P.I. 108,434	1.37	1.63	1.50	382	592	487
Pubescent, P.I. 107,330	2.27	2.20	2.23	471	302	386
Intermediate, tall, P-2327	3.67	3.10	3.38	434	175	304
Intermediate, dwarf, P-14	2.90	1.93	2.41	471	302	386
Crested standard, commercial	3.66	2.94	3.30	761	713	737
Crested, fairway, P-3171	2.03	2.19	2.11	707	645	676
Orchard grasses						
Common, P-3135	3.04	2.72	2.88	483	398	440
Tall Swedish, P-5310	2.66	2.67	2.66	506	307	406
Dwarf, P.I. 111,537	1.65	2.99	2.32	157	309	233
Tall Meadow Oat grasses						
Commercial, P-3052	2.70	2.54	2.62	260	229	244
Tualatin	3.15	2.91	3.03	387	430	408

of the crop both at Moscow and at Aberdeen. Redtop is an excellent seed producer. The 3-year average seed yields at Moscow were 384 pounds per acre. However, the same situation as was pointed out in the case of timothy seed prevails in redtop seed. For this reason redtop seed production is best limited to supply the demands for the seed within the state.

Bulbous barley is a rank growing grass resembling cultivated rye in its general appearance. It makes an early spring growth and is an early maturing crop. This tall growing bunchgrass presents a striking appearance. So far no use has been found for it. Under conditions at Moscow the crop was short-lived. Table 14 shows that

Table 17.—Hay yields of grasses in tons per acre for a 4-year period grown under irrigation at the Aberdeen Branch Station.

Grasses	Production year				4-yr. ave.
	1st	2nd	3rd	4th	
Bromegrasses					
Mountain	1.43	0.59	1.34	1.49	1.21
Smooth, Manchar	3.23	1.27	1.50	1.00	1.75
Smooth, commercial	2.96	1.17	0.97	0.88	1.50
Fescues					
Alta	2.23	0.86	0.82	0.67	1.15
Red	2.10	1.05	0.37	0.26	0.95
Sheep	1.12	1.47	1.34	1.51	1.36
Chewings	0.95	0.38	0.69	0.32	0.59
Idaho	0.93	0.77	0.88	0.61	0.80
Meadow	2.60	1.36	1.13	0.83	1.48
Wild-rye grasses					
Canada, P-786	3.25	2.23	2.50	1.91	2.47
Blue, P-2662	1.59	1.64	1.71	1.28	1.56
Wheatgrasses					
Standard crested	2.95	1.05	1.02	1.11	1.53
Slender, Primar	2.49	2.26	2.12	3.10	2.49
Beardless, Whitmar	1.57	2.32	1.04	0.80	1.43
Bluebunch, P-737	2.18	1.20	0.85	0.65	1.22
Dwarf crested	2.62	1.20	1.32	1.04	1.55
Intermediate, P-2327	2.49	2.22	0.95	0.92	1.65
Thickspike, P-1822	1.40	1.57	1.50	1.46	1.48
Bluegrasses					
Big blue, Sherman	2.16	1.94	1.73	1.56	1.85
Canada blue, P-410	2.44	1.65	1.15	0.86	1.53
Canada blue	2.74	1.37	1.47	1.57	1.79
Kentucky blue	1.19	0.42	0.71	0.72	0.76
Miscellaneous					
Redtop	2.67	1.03	1.36	1.20	1.57
Timothy	2.26	1.23	1.54	2.09	1.78
Tall meadow oat	1.68	1.52	0.96	0.86	1.26
Orchard	2.13	0.78	1.22	1.08	1.30
Bulbous barley, P-306	0.93	1.58	0.84	0.29	0.91
Reed canary	1.94	0.55	0.63	0.71	0.96
English rye	0.57	1.07			

while a fair yield was produced during the first crop year, yields declined rapidly in subsequent years. It was a rather poor seed producer at Moscow and also at Aberdeen.

Reed canary grass is a coarse though fairly palatable, wet-land, perennial, native to the northern parts of both hemispheres. It is one of the best grasses for land subject to periodic flooding. The use of reed canary grass need not be confined to wet lands. Table 14 shows that it produced excellent yields at Moscow where it was grown on upland Palouse soil. As a matter of fact it ranked second highest in forage yield of the 30 grasses tested. Only intermediate wheatgrass produced higher hay yields. The hay produced by reed canary is leafy and readily eaten by livestock. The crop should be cut for hay as the first heads appear.

Table 18.—Seed yields in pounds per acre of grasses grown under irrigation at the Aberdeen Branch Station, Aberdeen, Idaho.

Grasses	Production year				4-yr.
	1st	2nd	3rd	4th	ave.
Brome grasses					
Mountain, commercial	949	425	1,016	752	785
Smooth, Manchar	1,205	256	581	66	527
Smooth, commercial	1,039	215	211	26	373
Fescues					
Alta	495	172	308	140	279
Red	1,071	239	137	12	365
Hard, P-2517	1,001	835	568	462	716
Chewings	454	122	290	66	233
Idaho, P-2717	259	87	119	40	126
Meadow	1,065	314	533	431	586
Wild-rye grasses					
Canada, P-786	192	308	673	594	442
Blue, P-2662	681	428	686	132	482
Wheatgrasses					
Standard crested	483	163	52	29	182
Slender, Primar	1,161	695	752	634	810
Beardless, Whitmar	489	655	323	96	391
Bluebunch, P-737	399	349	528	264	385
Dwarf crested	1,024	116	230	15	346
Intermediate	306	93	15	T*	103
Thickspike	175	35	T	T	53
Bluegrasses					
Big blue, Sherman	858	146	449	356	452
Canada blue, P-410	1,390	372	151	210	531
Canada blue	785	384	311	26	376
Kentucky blue	582	116	81	79	214
Miscellaneous grasses					
Redtop	279	233	312	119	211
Timothy	422	285	340	457	376
Tall meadow oat	264	157	215	58	176
Orchard	370	122	306	87	221
Bulbous barley	40	221	93	T	88
Reed canary, Sandpoint	81	47	29	T	39
English rye	314	475	----	----	

* Trace of seed.

The main use of reed canary grass is for pasture. Except on land that is flooded periodically it should be grown in combination with alsike clover. Reed canary grass should be grazed heavy enough so that the animals will keep up with new growth, otherwise the plants will get too large and tough.

Reed canary grass is reproduced by seed and by vigorous underground rootstocks. Eradication of stands is not difficult in areas with dry summers, such as in the Palouse area. However, under conditions where the soil remains moist during the summer months, considerable difficulties have been encountered in eliminating old stands. This is true in the cut-over areas of Idaho. For this reason

Table 19.—Hay yields of 17 grasses grown in solid stands at the Tetonia Branch Station from 1941-1946. No hay yields were taken in 1942, and only the grasses producing seed crops were harvested in 1943.

Grasses and strains	Hay yields in tons per acre				Average yields
	1941	1944	1945	1946	
Wheatgrasses					
Crested, Standard	2.03	1.17	0.74	0.59	1.13
Crested, Fairway selection	1.58	1.01	0.99	0.44	1.01
Bluebunch, P-737	1.31	1.11	1.00	0.54	0.99
Intermediate, P-2327	1.91	1.61	1.55	0.69	1.44
Thickspike, P-1822	0.62	1.42	1.16	0.21	0.85
Slender, Primar	2.58	0.92	0.72	0.23	1.11
Pubescent, P-41	1.70	1.61	1.97	0.46	1.44
Bromegrasses					
Smooth, commercial	2.62	0.94	1.38	0.47	1.35
Erect, P-2336	1.94	0.54	0.32	0.26	0.77
Mountain, Bromar	1.96	0.73	0.12	N.S.*	----
Fescues					
Chewings, commercial	0.61	0.83	0.69	0.15	0.57
Hard, P-2517	1.34	1.11	1.15	0.34	0.99
Wild-rye grasses					
Canada, P-2623	2.60	0.87	0.10	0.31	0.97
Blue, P-2662	1.57	1.04	0.10	N.S.	----
Miscellaneous					
Orchard grass, commercial	0.77	0.69	0.74	0.27	0.62
Tall meadow oat, commercial	0.88	1.17	0.98	0.36	0.85
Big blue, Sherman	1.20	1.60	2.70	0.48	1.50

* N.S. No stands; stands were reduced to the point where they were not considered adequate for yield determinations.

reed canary grass had best be kept out of crop rotation systems in moist areas.

The seed habits of reed canary grass are decidedly poor. Most of the seed now available on the market is stripped by hand, a laborious and expensive process. The seed yields reported in Tables 15 and 18 were obtained by harvesting the crop with a binder. The average yields were only 33 and 39 pounds per acre at Moscow and Aberdeen.

English ryegrass is a short-lived perennial used for hay and pasture in moist areas with mild winters. The grass is not sufficiently hardy to withstand severe winter conditions. This accounts for the low yield reported in Table 14.

Table 20.—Seed yields of 17 grasses grown in solid stands at the Tetonia Branch Station from 1941-1944.

	Seed yields in pounds per acre				
Grasses and strains	1941	1942	1943	1944	Av. yield for first 2 years
Wheatgrasses					
Crested, standard commercial	557	207	-----	178	382
Crested, Fairway selection	401	68	-----	40	235
Bluebunch, P-737	396	261	-----	-----	329
Intermediate, P-2327	98	19	-----	-----	59
Thickspike, P-1822	52	38	14	-----	45
Slender, Primar	930	395	135	145	663
Pubescent, P-41	-----	60	-----	97	-----
Brome grasses					
Smooth, commercial	544	110	21	105	327
Erect, P-2336	633	121	-----	-----	377
Mountain, Bromar	819	73	-----	234	446
Fescues					
Chewings, commercial	259	102	-----	-----	181
Hard, P-2517	598	292	50	-----	445
Wild-rye grasses					
Canada, P-2623	520	210	-----	221	365
Blue, P-2662	381	18	108	185	200
Miscellaneous					
Orchard grass, commercial	161	20	-----	-----	91
Tall meadow oat, commercial	74	91	-----	145	83
Big blue, Sherman	393	405	-----	-----	399