Smooth Bromegrass Seed Production in Michigan
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SMOOTH BROMEGRASS
Seed Production
in MICHIGAN

By B. R. Churchill

MICHIGAN STATE COLLEGE :: AGRICULTURAL EXPERIMENT STATION

SECTION OF FARM CROPS

EAST LANSING

HIGHLIGHTS

1. Seed of smooth bromegrass may be harvested from bromegrass-alfalfa mixtures or from pure stands of bromegrass. Yields of seed in Michigan have ranged from 300 to 700 pounds per acre for fields in their prime. Old stands yield considerably less. Page 12.

2. When grown in pure stand strictly for seed production, seed bromegrass with oats in early August. Mix ½ bushel of oats with ½ bushel of bromegrass seed and seed in rows 30 to 36 inches apart. Page 8.

3. Seed shallow on a firm, clean seedbed. Page 8.

4. For pure stands of bromegrass, apply 300 to 400 pounds per acre of 0-20-20 fertilizer before seeding or a 3-12-12 if the soil is low in nitrogen. (Fertilizers of similar analysis may be substituted.) Each spring, add a top dressing of 200 to 300 pounds per acre of ammonium sulfate or similar nitrogen fertilizer. If bromegrass is grown with alfalfa, fertilize at time of seeding to meet the requirements of alfalfa. Page 8.

5. Do not harvest for seed any field known to contain quackgrass. Page 13.

6. Combine, as high as possible, when most of the seed is brown and some of the stems are yellow for a few inches below the panicle. Page 16.

7. If seed is tough, spread on a clean floor for a few days; turn with a shovel each day to dry. Page 19.

8. Pasture the forage remaining after seed harvest or cut and remove for hay. Page 17.

9. Have the seed cleaned by a commercial seed-cleaning establishment or clean on the farm with a fanning mill. Page 20.

10. Good seed should show a purity of more than 90 percent, be free from quackgrass or other noxious weeds, practically free of other weed or crop seeds, and have a germination of 90 percent or better. Page 21.

Smooth Bromegrass Seed Production in Michigan

By B. R. CHURCHILL

SMOOTH BROMEGRASS *(Bromus inermis Leyss)* IS A LONG-LIVED, PERENnial grass that under normal conditions forms a dense sod. It is resistant to drouth, very palatable to livestock even at advanced stages of maturity, and when abundantly supplied with plant nutrients, especially nitrogen, bromegrass is highly productive.

In recent years, bromegrass has become one of the most important forage and pasture grasses in Michigan. The wide appreciation of its superior value is due to the fact that nearly all bromegrass in this state is seeded with alfalfa from which it gets its much needed nitrogen.

It is true that bromegrass seeds resemble the seeds of quackgrass in size and shape. Bromegrass plants also spread, moderately, by means of underground stems or rhizomes. This similarity to quackgrass is not marked. Although some strains of bromegrass show a greater tendency to spread than others, none of them, under Michigan conditions, has been obnoxiously aggressive like quackgrass. Several bromegrass fields at Michigan State College have been plowed up during the past 10 years, and the bromegrass has been controlled as readily by plowing and the usual practices involved in preparing a good seedbed as old sods of Kentucky bluegrass (Junegrass) or timothy.

The root system of a 3-year-old bromegrass plant is shown in Fig. 1A. Its rhizomes are few in number and small, its fibrous roots numerous. On the other hand, the rhizomes of quackgrass (Fig. 1B) are large and numerous and there is a much smaller number of fibrous roots.

Bromegrass plants are usually leafy and under humid conditions remain green even after seed has ripened. The plant starts slowly if planted too deeply, but once established it begins growth early in the spring. Seeds are produced in open panicles resembling oats, but are much smaller and lighter in weight.

Bromegrass is tolerant of drouthy conditions because of the ability of its root system to reach the moisture in the soil and not because of its low water requirement. According to Dillman[1] and, also, Shantz and Piemeisel,[2] the water requirement of bromegrass is about the same as

[1]Dillman, Arthur C. Water requirement of certain crop plants and weeds in the Northern Great Plains. Jour. Agr. Res. *42*:187-239. 1931.

[2]Shantz, H. W. and Piemeisel, Lydia N. Water requirement of plants at Akron, Colorado. Jour. Agr. Res. *34*:1093-1190. 1927.

Fig. 1. A comparison of bromegrass and quackgrass.
(A) A three-year-old plant of smooth bromegrass, showing a typical root system as grown under Michigan conditions.

(B) A quackgrass plant, showing the type of underground growth this species normally produces in Michigan. The bromegrass and quackgrass plants shown in these pictures were dug from the same field in early November.

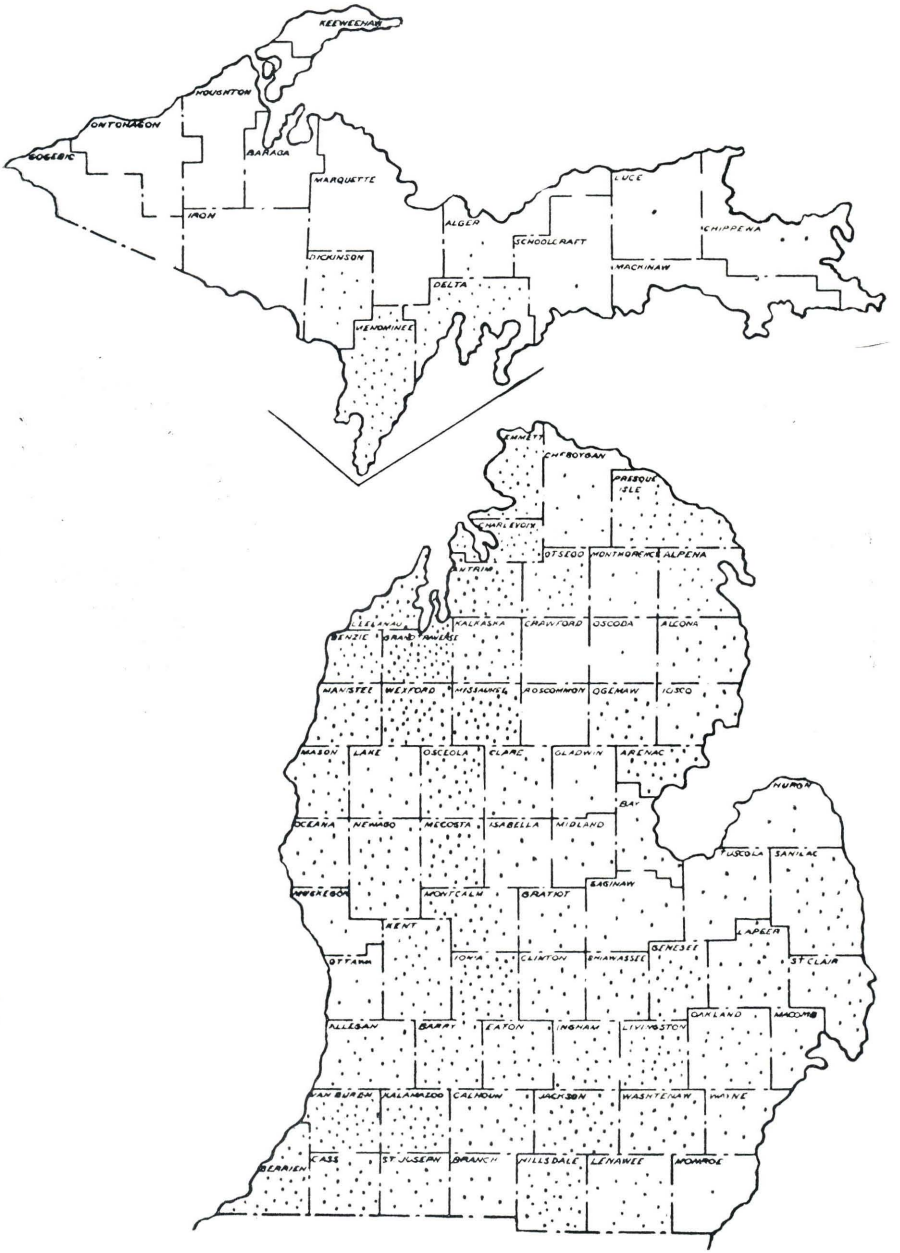

Fig. 2. Acreage of smooth bromegrass seeded with alfalfa in Michigan in 1940, as reported by the Agricultural Adjustment Administration. Each dot represents 100 acres.

that of alfalfa; three times that of millet; two and one-half times that of corn; and one and one-half times that of wheat, oats or potatoes. Its palatability is high, and in mixtures with alfalfa it has furnished a very desirable productive pasture, especially during that period of the summer when ordinary bluegrass pastures are unproductive. Forage and seed yields from pure stands of bromegrass are decidedly lower after the first or second year unless nitrogen fertilizer is applied. Older stands, however, produce more forage than Junegrass pastures in Michigan.

Bromegrass has been grown in Michigan for 25 years or more. Not until bromegrass was seeded in mixtures with alfalfa, however, did it become popular in the state. The increase in acreage of this mixture has been very rapid in the past 5 years. In 1940, according to reports of the United States Agricultural Adjustment Administration, there were 102,914 acres of smooth bromegrass seeded in Michigan, all of which were in mixtures with alfalfa. Figure 2 shows the distribution of the acreage by counties. The map does not represent total acreage grown, but includes only the acreage seeded in 1940 on farms cooperating with the Agricultural Adjustment Administration program. If an average of 5 pounds of seed were seeded per acre, there were more than one-half million pounds of smooth bromegrass seed used in Michigan in that year. It would seem that a conservative estimate of the 1943 acreage of smooth bromegrass in Michigan would be one-half million acres, almost all of which was originally seeded with alfalfa. The chief use of bromegrass in Michigan is as a pasture crop in combination with alfalfa, although the mixture also makes a very desirable hay.

The rapid increase in acreage of smooth bromegrass in the state has stimulated interest in seed production of the crop; hence, studies have been carried on at the Michigan Agricultural Experiment Station to determine effective cultural procedures. In 1937, a source of bromegrass seed was found in the state from which row plantings were made on the Farm Crops Department field plots at East Lansing. This seed was from a five-year-old field of Canadian bromegrass grown on the A. R. Bittner farm near Reese, Michigan. All smooth bromegrass seed now certified in the state traces back to this plot; however much of the seed produced in the state is from plantings made with seed from other sources. In cooperative state and federal experiments throughout the United States, the Michigan strain has been designated B-2.

SEEDING PROBLEMS

Seed of smooth bromegrass is light, having a standard test weight per bushel of only 14 pounds. The seeds are large, as compared with seeds of redtop, bluegrass, reed canarygrass and other commonly grown

perennial grasses. Seeds are flat, somewhat chaffy and, if poorly threshed, will have attached sterile florets, which add further to their chaffiness. Because of these characteristics, the seed will not feed through the grass seeder box of an ordinary grain drill, nor will it feed uniformly through the grain box compartment. Special drills used to seed other grasses and small seeded legumes are not satisfactory for the same reason.

When bromegrass is not broadcast by hand, mixing it with some other crop seed has been the common method of seeding in Michigan. Spring plantings are usually put in with a companion crop of oats or barley. Seed of the grain crop is mixed with bromegrass seed, usually at the rate of 1½ bushels of grain to ⅓ to ½ bushel (about 5–7 pounds) of bromegrass. This mixture feeds through the grain compartment satisfactorily, but may require occasional stirring to keep the seeds of the two crops well mixed. The drill should be set to seed at a higher rate than when seeding grain only. Some allowance must be made for the fact that a bromegrass-oats mixture feeds through a drill more slowly than grain unless the oats seed used in the mixture is unusually heavy. Thus, if one plans to seed oats weighing approximately 32 pounds per bushel at 1½ bushels per acre and adds to this 7 pounds (approximately ½ bushel) of bromegrass seed, the drill will need to be set to sow at a rate of somewhat more than 2 bushels per acre. (Try 2¼ bushels.) On the other hand, if oats weighing 40 pounds per bushel are mixed with bromegrass of more than 90-percent purity the mixture will be seeded at about the right rate when the drill is set to sow oats at 7 pecks (1¾ bushels) per acre.

Bromegrass seed may also be seeded with wheat in the fall, although this date is too late to seed alfalfa in Michigan. The alfalfa, however, may be seeded on wheat the following spring. Bromegrass with wheat does not stay mixed so well as with oats or barley and more stirring will be necessary.

Small areas may be seeded with a wheelbarrow fertilizer seeder followed by a cultipacker. In one or two instances, the crop has been seeded through a special box drill mounted on a cultipacker and operated by a trailer wheel on the principle of the wheelbarrow seeder.

If the seeding is made in early August, it is still desirable to mix oats with the bromegrass, using only ½ bushel of oats with each ½ bushel of bromegrass. The growth of the oats will not interfere with the bromegrass and the oat plants will be killed by freezing in the late fall. Alfalfa can be seeded through the grass seeder box at the same time. In order to determine proper drill settings for such a mixture of oats and bromegrass, drill calibrations were made, using oats weigh-

ing 33 pounds and oats weighing 40.5 pounds per bushel. It was found that the drill seeded the lighter oats-bromegrass mixture at the proper rate (½ bushel of each per acre) when set to sow 1⅜ bushels of straight oats. Proper drill-setting for the heavy oats-bromegrass mixture was at ⅞ bushel of oats.

A few growers producing certified seed have planted bromegrass in rows varying from 24 to 30 inches apart. When row-spaced in this way, seeding in the spring with a nurse crop is complicated and difficult. Building special compartments for drilling the grain-bromegrass mixture in 28-inch rows while oats only are sown through the remaining openings, has not been practical. A few growers have seeded oats first and then row-drilled a mixture of oats and bromegrass, but this method requires drilling the field twice. The most satisfactory method of row-planting the crop is to mix bromegrass and oats in equal parts by volume, plug necessary holes in the drill properly to space the rows, and seed in early August.

A mixture of 5 to 7 pounds of bromegrass and 6 to 8 pounds of alfalfa per acre has proved very satisfactory for pasture, hay or bromegrass seed production. If bromegrass is seeded in rows 28 inches apart for seed production, from 2 to 2½ pounds of seed will be required per acre. If rows are 28 inches apart and ½ bushel of oats is mixed with each ½ bushel of bromegrass, each acre will require approximately 4 pounds of oats.

Regardless of method or time of seeding, shallow planting is desirable. Bromegrass planted too deeply is delayed in reaching the surface, and often more weak plants result. Seeding on the surface followed by cultipacking has given quick growth and good stands. If the seed is run through the grain compartment of the drill with oats, and the drill is inclined to run too deeply, the grain spouts may be removed. This method, followed by cultipacking, has given excellent results in trials by the Farm Crops Department of Michigan State College, East Lansing.

Whether bromegrass is seeded with alfalfa or alone, the seedbed should be firm and free from weeds. Bromegrass for seed production should not be planted on a field that has had quackgrass unless the quackgrass has been completely killed. If seeded with alfalfa, the field should be fertilized as required to meet the needs of the alfalfa. If bromegrass is seeded alone for seed, a complete fertilizer or one high in phosphorous and potash, such as an 0-20-20, 0-14-14 or similar analysis, applied at the rate of 300 to 400 pounds per acre, may be desirable. Nitrogen should be applied annually as a top dressing in early spring.

MANAGEMENT FOR SEED PRODUCTION

Although bromegrass-alfalfa mixtures are primarily seeded for forage, more than 90 percent of the bromegrass seed crop in the state is harvested from such mixtures. Highest yields of seed are produced from relatively new stands in which both bromegrass and alfalfa have become well established. Often in the first crop year the alfalfa will predominate and the bromegrass-seed yield under such conditions will be light. In wet seasons, however, the grass may grow rapidly and produce an excellent seed crop the first year. Old fields from which almost all of the alfalfa has long since disappeared produce low yields of bromegrass seed. In many instances throughout the state, more profitable yields of seed would be obtained if more recent seedings, still containing a good stand of alfalfa, were harvested.

Judicious pasturing of the stubble from the current year's seed crop or pasturing a field from which bromegrass seed will be produced the following season is not considered injurious to the seed crop. However, any fall treatment which decreases the stand of the alfalfa may cause lower bromegrass seed yields the following summer. In a date-of-clipping test in 1941, clipping in the spring at various stages of growth reduced the number of head-producing stems; the later the clipping was made, the fewer heads produced. Under Michigan conditions, no seed is produced from a second cutting of bromegrass even when the first cutting is made very early.

Bromegrass requires large amounts of nitrogen, and if this element is lacking a low yield of seed results. When grown in mixture with alfalfa, the bromegrass utilizes the nitrogen supplied by the alfalfa. When grown alone, the nitrogen must be applied as fertilizer unless the soil is already rich in this plant food element, as on muck. When the nitrogen supply is excessive and conditions are favorable for rapid growth, the bromegrass lodges and prospects for a good seed crop are materially reduced. If lodging occurs early and the bromegrass remains down, little seed will be produced. If the bromegrass remains upright, the seed crop will be proportional to the number of heads.

Results of studies by Harrison and Crawford[1] in 1938 and 1939 indicated that seed yields of bromegrass in pure stands could be increased by the application of available nitrogen. More extensive experiments, therefore, were seeded in the fall of 1939 and continued through the 1943 season. In 1940, bromegrass planted in rows 28 inches apart and kept cultivated produced 150 pounds of seed per acre. Bromegrass broadcast (drilled in rows 7 inches apart) produced 151 pounds per acre. A plot of alfalfa-bromegrass mixture yielded 86 pounds of bromegrass seed per acre.

[1]Harrison, C. M. and Crawford, W. N. Seed production of smooth bromegrass as influenced by applications of nitrogen. Jour. Amer. Soc. Agron. *33*:643-651. 1941.

TABLE 1—*Effect of cultural treatments upon the seed yield of smooth bromegrass at East Lansing, Michigan, in 1941.*

Treatment	Seed yield in pounds per acre	
	28-inch rows (cultivated)	Broadcast
Alfalfa-bromegrass mixture	—	303
No treatment	363	155
200 pounds ammonium sulfate in early spring	558	248
400 pounds ammonium sulfate in early spring	590	321
800 pounds ammonium sulfate in early spring	609	319

In the spring of 1941, ammonium sulfate was applied to some plots at rates of 200, 400 and 800 pounds per acre. Results of these trials are given in Table 1. Data in Table 1 indicate that both cultivation and the application of ammonium sulfate were beneficial and that alfalfa supplied much of the needed nitrogen. The most practical rate of application for ammonium sulfate was 200 pounds per acre where the bromegrass was in rows and 400 pounds per acre where it was broadcast.

Some of the plots harvested in 1942 were fertilized with ammonium sulfate in September 1941, while others received applications of the same fertilizer in April of 1942. Rates of application were the same as the previous year as given in Table 1. In addition, some plots from the broadcast area were double-disked in early spring with a tandem disk to determine the effect of disking on seed yields. Results of the 1942 experiments are given in Table 2.

TABLE 2—*Effect of cultural treatments upon the seed yield of smooth bromegrass at East Lansing, Michigan, in 1942.*

Treatment	Seed yield in pounds per acre	
	28-inch rows (cultivated)	Broadcast
Alfalfa-bromegrass mixture	—	124
No treatment	200	90
Spring double-disked with tandem disk	—	70
200 pounds ammonium sulfate in September	339	234
400 pounds ammonium sulfate in September	398	326
800 pounds ammonium sulfate in September	363	347
200 pounds ammonium sulfate in April	335	190
400 pounds ammonium sulfate in April	322	159
800 pounds ammonium sulfate in April	177	78

Bromegrass grown in rows and cultivated produced twice as much seed per acre as that grown in broadcast plots when no fertilizer was applied. Use of ammonium sulfate was again profitable. Nitrogen applied either in fall or spring was beneficial, but too much nitrogen caused lodging and substantial reduction in yields. Lodging was very severe on plots receiving 800 pounds of fertilizer in early spring, and some plots receiving 400 pounds per acre lodged severely. When lodging was not a factor, 200 pounds of ammonium sulfate per acre on cultivated plots and 400 pounds per acre on broadcast plots were the most practical rates of application. When lodging was a factor as in the case of plots receiving 400 or 800 pounds of fertilizer in April, the 200-pound rate was best for both rowed and broadcast plots. Double-disking broadcast plots did not increase yields.

No treatments were made in 1943, but plots were harvested to study the residual effect of previous treatments. These results are given in Table 3.

Data in Table 3 show that plots which received applications of ammonium sulfate at some time previous to 1943 produced less seed in 1943 than "no treatment" plots on which this fertilizer had never been applied. Bromegrass grown in combination with alfalfa produced an average of 174 pounds of seed per acre, as compared with 121 pounds per acre for bromegrass alone in broadcast plots, or an increase of 44

TABLE 3—*Residual effect of cultural treatments upon seed yields of smooth bromegrass at East Lansing in 1943 and effect of a companion alfalfa crop and cultivation upon average seed yields for the period 1940 to 1943.*

Treatment	Seed yield in pounds per acre	
	28-inch rows (cultivated)	Broadcast
Alfalfa-bromegrass mixture	—	183
No treatment	175	89
Double-disked with tandem disk in spring, 1942	—	92
200 pounds ammonium sulfate in September, 1941	137	66
400 pounds ammonium sulfate in September, 1941	91	58
800 pounds ammonium sulfate in September, 1941	76	49
200 pounds ammonium sulfate in April, 1941 and 1942	121	45
400 pounds ammonium sulfate in April, 1941 and 1942	131	56
800 pounds ammonium sulfate in April, 1941 and 1942	99	62
Alfalfa-bromegrass mixture, 1940-43 average	—	174
No treatment, 1940-43 average	222	121

percent for the four-year period. Bromegrass grown in rows and cultivated averaged 222 pounds per acre as compared with 121 pounds per acre for bromegrass that was broadcast, or an 83-percent increase for the four-year period.

HARVESTING THE COMMERCIAL CROP

One of the first questions asked by growers is, "How can we tell if there is enough seed to make harvest worthwhile?" From observations of experimental plots and commercial fields, the author questions the economy of harvesting fields that yield less than 100 pounds per acre. Yields of more than 300 pounds per acre are often obtained in this state, and frequently yields of more than 500 pounds per acre are obtained. One field in 1942 yielded more than 700 pounds per acre.

Michigan growers have found that experiences with other crops help very little in estimating seed yields of smooth bromegrass. The two characteristics which best indicate seed yield are number of heads per unit area and the amount of lodging. Under a given climatic condition, maximum yields are obtained from stands showing numerous heads with dense undergrowth of shoots and leaves, with no lodging. Old stands that have become sodbound and lack nitrogen fail to pro-

Fig. 3. The bromegrass on the left received 200 pounds of ammonium sulfate per acre while that on the right received 800 pounds per acre. Fertilizer was applied to these plots in April 1942, and the picture was taken in July of the same year. Too much nitrogen causes bromegrass to lodge severely and reduces seed yields.

duce many heads. Frequently under those conditions, the heads will also be small and few tillers will be produced.

In 1942 on experimental plots at East Lansing, fairly accurate estimates of seed yields were obtained by counting the number of heads per square yard and assuming one pound of seed per acre for each head per square yard. Of course this method requires care in measuring the square yards and making enough counts to give an average of all conditions in the field. Estimates based on this method were more accurate at medium yields than when yields were either low or very high.

On soils containing large amounts of available nitrogen and especially in wet seasons, bromegrass lodges severely. Under such conditions the grass makes unusual vegetative growth, but produces very little seed. The effect of excess nitrogen can be noted in yields of plots in 1942 receiving 800 pounds of ammonium sulfate per acre in early spring as shown in Table 2. Figure 3 shows the vegetative condition of this plot compared with that of a plot receiving 200 pounds of fertilizer per acre.

When seed yields are less than 100 pounds per acre, the bromegrass will either be very thin on the ground or will be lodged severely. Figure 4 shows a 3-year-old stand of bromegrass that was originally seeded with oats as a companion crop. The plot received no ammonium sulfate and yielded 90 pounds per acre. Note the thin stand of bromegrass heads, lack of shoots and leaves, and the abundance of volunteer alsike clover. Compare Fig. 4 with Fig. 5. Bromegrass in Fig. 5 was planted at the same time and in the same manner but received a topdressing of 400 pounds per acre of ammonium sulfate in September of 1941. This plot produced 326 pounds of seed per acre in 1942. Note the number of heads, thick undergrowth of shoots and leaves, and the absence of alsike clover as compared with the bromegrass in Fig. 4. In general, a field might be considered worthwhile to harvest if plants have not lodged badly and if heads are thick enough to make walking through the field somewhat difficult.

Watch out for Quackgrass:

Having decided that the field will yield enough to justify seed harvest, a careful examination of the field should be made to determine the possible presence of noxious weeds, especially quackgrass. Looking for the quackgrass before the bromegrass is headed out is useless because the two plants are not easily distinguished. After heading, the two plants can be distinguished readily, as shown in Fig. 6. If quackgrass is found, no attempt at rogueing will be satisfactory because some plants will be missed. Attempts to miss the quackgrass by driving around the weed area will help but very little, for when such patches

Fig. 4. A 3-year-old stand of bromegrass. No nitrogen was applied at any time after seeding. Volunteer alsike clover is abundant, indicating that the bromegrass is thin. This plot yielded 90 pounds per acre. Ordinarily, harvesting of such fields would not be profitable.

Fig. 5. Fields of bromegrass like this are profitable for seed production. This plot was fertilized in September 1941, with 400 pounds per acre of ammonium sulfate and yielded 326 pounds of seed per acre in 1942. Compare with Fig. 4.

Fig. 6. After quackgrass heads out, it is easily distinguished from bromegrass. The two figures on the left are different views of heads of quackgrass, while the figure on the right is bromegrass.

Fig. 7. The three figures on the left are of smooth bromegrass while the three on the right are of quackgrass.

are skipped there are usually smaller areas harvested which contaminate the seed. In Michigan, as in 36 other states, quackgrass is a noxious weed by law and seed containing it is limited in sale if not excluded. There is no commercial method of removing quackgrass seeds from bromegrass because the two are very much alike in size and shape, as shown in Fig. 7.

Bromegrass fields containing quackgrass, therefore, should not be harvested for seed even though the prospects are for a high yield. If the field contains other noxious weeds, such as Canada thistle, perennial sow thistle or wild carrot, which cannot or will not be rogued out previous to harvest, it is also advisable to use it for pasture or hay rather than for seed.

In addition to quackgrass and other noxious weeds, the presence of chess, downy brome and curled dock may make harvesting a seed crop inadvisable. When only a few scattered dock are present they can be pulled just previous to harvest or as the field is combined. If the field contains numerous weeds of other species, it is inadvisable to harvest the crop for seed.

When to Harvest:

Until one has had considerable experience in harvesting bromegrass seed, it is difficult to determine just when the crop is ready to harvest. Examination of several samples of threshed seed indicates that in several instances at least, the harvest was delayed too long. When such is the case some of the seed is lost by shattering and the harvested seed is frequently of lower quality. Under similar threshing conditions, seed is often a darker, duller color, hulls are looser and more frayed, and usually a higher percentage of the seed is dehulled.

Bromegrass as grown in Michigan does not ripen from the ground up, but ripens in the kernels and panicles first. The base of the plants remains green long after harvest and can be utilized for hay or pasture. As the crop ripens some of the heads will show a purple color. This color develops before the crop is ready to harvest for seed and changes to a brown color as ripening progresses. For binder harvest, the crop normally should be harvested before all of the purple color disappears. At harvest most of the seeds will be brown and the branches of the panicle yellow. At this stage many of the stems turn yellow for several inches below the panicle; however, the percentage of yellow stems varies from season to season and field to field. As is the case with other crops, combine harvest should be made a few days later than binder harvest. The crop shatters its seed to a greater extent than wheat or oats and should be harvested before this stage is reached.

How to Harvest:

The crop may be harvested with a binder or by combine. The latter is preferred, especially if the bromegrass is in a mixture with alfalfa. When a binder is used, the stubble should be left as high as possible so that much of the green base can be left out of the bundles. The crop should be shocked in long narrow uncapped shocks to cure before threshing. Figure 8 shows a field of bromegrass grown in rows being harvested with a binder.

If the crop is not lodged badly, a combine is very satisfactory for harvesting bromegrass seed. The cutter bar may be set high enough to miss almost all of the alfalfa and most of the green leafy base of the bromegrass plants. Combining from the standing crop is much more satisfactory than any attempt to combine from windrows. This is especially true if the crop is in mixture with alfalfa. As soon as the seed crop is removed from the field the stubble may be cut for hay or pastured. While the alfalfa will be past the best stage for high quality, a fair yield of medium quality hay results. One Michigan farmer com-

Fig. 8. Harvesting smooth bromegrass seed with a grain binder. Bundles are set in long narrow, uncapped shocks to cure. This field is a 3-year-old stand of bromegrass, seeded in rows 28 inches apart and cultivated each spring and fall.

Fig. 9. This bromegrass-alfalfa mixture produced over 500 pounds of bromegrass seed per acre and about 1½ tons per acre of hay. The combined seed showed a purity of 96 percent. See Fig. 10.

bined bromegrass seed from a bromegrass-alfalfa mixture and cut the stubble for hay the same day, in fact the mower kept up with the combine, as shown in Figs. 9 and 10.

Fig. 10. The same field of bromegrass-alfalfa shown in Fig. 9. The mower with windrow attachment followed the combine around the field. Note the combine in the distance ahead of the mower.

Threshing Bromegrass Seed:

Bromegrass seed may be threshed with an ordinary thresher or combine with only minor changes. An examination of several commercial samples of Michigan threshed seed, however, indicates that more experience is needed, as threshed samples have ranged from approximately 60 percent to 97 percent purity even when weed seeds and other crop seeds were not a problem.

Although seed is inclined to shatter, it must be rubbed or threshed rather severely to separate properly the individual seeds. Thus round teeth in cylinder or concaves fail to do a satisfactory job. Similar unsatisfactory results are obtained if the cylinder is run too slowly or if too few concaves are used. In most instances it seems advisable to use the same speed of cylinder and number of concaves as is customarily used for oats. If too many seeds are dehulled it is probable that the concaves are set too close to the cylinder or perhaps too much seed is carried forward by the tailings elevator.

Adjustable sieves should be closed more than for oats, especially the lower one. Where sieves are not adjustable, the upper should be a ⅜-inch or ½-inch lip rather than the customary 1¼-inch lip used for oats. If a screen is used, an oblong, slotted wire screen is recommended as round-hole screens commonly used for wheat plug much more readily.

The most important adjustment is the air. Bromegrass seed is relatively light, having a standard test weight per bushel of only 14 pounds, and is easily blown over with the chaff. In spite of this, an examination of threshed samples indicates that in many cases not enough air was used. A careful check should be made of the chaff being blown over since empty chaff at first glance may appear to be good seed. In some machines it may be necessary to close the air intake of the fan at least in part with cardboard. The air adjustment should not be made by running the machine slower as this will cause the racks to "choke up".

How to Handle Threshed Seed:

Threshed seed that is tough (too high in moisture content) will heat and spoil in storage. Such seed must be dried in some manner before storing. If space is available, it can be spread on a clean floor for a few days and shoveled often enough to prevent heating. When the seed is of low purity and contains pieces of green leaves and stems, one "run" over a fanning mill will reduce the bulk from 25 to 50 percent and remove most of the green material. A few growers have corn dryers available on their own farms or in the neighborhood which could be used to advantage. Only seed of reasonably high purity should be placed in dryers. It is poor economy to dry the impurities which are often higher in moisture content than the seed, and space in the dryer may be

at a premium. Seed containing only a slight excess of moisture can be placed in loose mesh bags and stood in the dryer with sufficient space around each bag to permit circulation of air. Seed should not be packed into the bags. If the seed is more than slightly tough, arrangements should be made to spread the seed in a thin layer rather than to dry it in the sacks. Bromegrass seed containing noxious weeds cannot profitably be artificially dried. Under Michigan conditions bromegrass seed ordinarily should not be dumped into storage bins at time of threshing.

How to Clean the Seed:

Cleaning seed of smooth bromegrass is a major problem in the marketing of the crop. Wide variations in the purity of threshed lots of seed, possible contamination with quackgrass, and lack of space and suitable equipment for cleaning are major factors which increase the difficulties of commercial cleaning of the seed. Commercial seed cleaning establishments find it difficult to set a fair charge for cleaning when lots vary so much in purity. Bromegrass with a purity exceeding 90 percent may be cleaned in half the time required to clean a lot having a purity of only 70 percent. In any case, cleaning the seed is a slow job. Commercial dealers hesitate to clean bromegrass that may contain quackgrass because the quackgrass cannot be removed and they know that the grower may find it impossible to sell his seed even after paying the expense of cleaning.

Bromegrass seed is bulky and requires a comparatively large space for storage, and most seed cleaning plants are already overcrowded. In cleaning, bromegrass seed requires a special force-feed hopper, built above the mill, as thresher-run seed otherwise will not feed onto the screen. When these three difficulties are overcome more bromegrass will be cleaned by the large mills in the state. The first two can be corrected by the growers themselves by refusal to harvest quackgrass-infested fields and by more careful threshing.

Although faster and more efficient cleaning can be done by large mills with traveling brushes, the seed can be cleaned on the farm with farm-sized fanning mills. The biggest disadvantage of cleaning seed on the farm is the time required. The job requires a man's full time while the mill is in operation and often the seed will need two "runs" over the mill to fit it for sale. The air should be regulated to blow out almost all of the chaff, but the air intakes of the fan will need to be shut off approximately four-fifths with cardboards to avoid blowing out the good seed. When the proper adjustment is reached a few good seed will be blown over with the chaff.

The proper choice of screens depends upon the condition of the seed and the amount and kind of impurities to be removed. If the seeds

have been threshed hard enough to break up thoroughly the spikelets, a 5/64-inch x 5/16-inch zinc upper screen should be satisfactory. If the seed is not broken up well, or is very trashy, try a 1/14-inch x 1/2-inch or a 1/13-inch x 1/2-inch zinc upper screen for the first run. When the impurities contain yellow foxtail or lady's-thumb, a 7/64-inch round hole screen above will scalp off most of the bromegrass and give the lower screen greater efficiency. If the seed is well threshed and of relatively high purity, a 6- by 24-wire screen (6 mesh openings lengthwise by 24 mesh openings crosswise the screen) is recommended for the bottom. This screen will remove fine particles of dirt and chaff along with some timothy and small seeded weeds. A number nine buckwheat screen is very efficient in scalping off the bromegrass and separating it from curled dock, closely-threshed wild carrot, timothy, alsike clover and lady's-thumb. Inserted with points uphill, this screen is practically self cleaning and can be used as a bottom screen.

STANDARDS FOR SMOOTH BROMEGRASS SEED

Certified seed is recognized as superior, but only a small percentage of the seed produced is certified. In 1941 slightly more than 250,000 pounds of smooth bromegrass seed was certified in the United States. In Michigan, thus far only those fields have been inspected which were planted in rows and cultivated. It is recognized, however, that high quality seed is harvested from bromegrass-alfalfa mixtures and that such a method is a practical way of handling the crop.

Regardless of how the seed was grown and harvested, it should meet certain standards as to purity and germination. In Michigan a minimum purity of 92 percent has been emphasized. Furthermore, the impurities should consist of not more than 1/10 of 1 percent of weed seeds and not more than 5/10 of 1 percent of other crop seeds. The seed should be free from noxious weed seeds. A minimum germination of 90 percent has been the basis for seed certification in the state. It is possible for seed to have a purity of over 99 percent and germination of 95 percent yet still be unsalable because of the presence of too many quackgrass seeds. The Michigan seed law prohibits the sale of seed which contains more than one noxious weed seed to 2,000 seeds of the crop. (With smooth bromegrass, this would mean approximately 68 quackgrass seeds per pound.)

WHAT TO DO WITH UNMARKETABLE SEED

Fields containing noxious weeds or an excess of other weeds should not be harvested for seed. Some fields containing quackgrass are harvested because the operator is unaware of the presence of the quackgrass. Seed that is unmarketable because of noxious weed seeds and

TABLE 4—*Composition of bromegrass seed compared with that of oats and barley.*

Crop (grain)	Percent				
	Ash	Crude protein	Crude fiber	Fat	Nitrogen-free extract
Smooth bromegrass	4.8	16.0	12.8	1.4	65.0
Oats	3.8	13.5	12.1	4.8	65.8
Barley	3.2	14.2	6.1	2.5	74.0

other seed whose germination is too low for seeding purposes may be ground and fed to livestock. Although the digestibility of bromegrass seed is not known, a chemical analysis shows its composition to be similar to that of oats as shown in Table 4. The sample analyzed chemically showed the following seed analysis:

Pure seed	92.97%
Inert material	6.62%
Other crop seed	0
Weed seeds	0.41%

Bromegrass seed of lower purity containing more trash (stems, leaves, chaff) would be lower in feeding value because of its lower protein and higher fiber content.