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# Trials with Millets and Sorghums for Grain and Hay in South Dakota

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In Co-operation with United States Department of Agriculture
Bureau of Plant Industry

SOUTH DAKOTA
STATE COLLEGE OF AGRICULTURE
AND MECHANIC ARTS

AGRONOMY DEPARTMENT

# Trials With Millets and Sorghums for Grain and Hay in South Dakota

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# Summary of Bulletin 135

I. The highest average yield of grain secured at Highmore from any variety of millet, in years 1907–1910, was 17.6 bushels per acre, from common millet. Page 315.

2. The next highest average yield was 16.0 bushels per acre from Black Voronezh, this being also practically the yield from Kursk, and Tambov varieties. Page 315.

3. Kursk varieties of millet in 1910, produced a higher yield of hay, and are, all considered, most promising, the average of the highest yields of Kursk for all seasons being 24.7 bushels of grain per acre. Page 317.

4. The facts apparently warrant the increased use of Kursk millet, as a grain crop in South Dakota. Page 318.

5. It requires a longer time for grain sorghums to grow to maturity than for millet. Page 326.

6. The average yield of grain per acre for three strains of Kowliang (grain sorghum) for three years, including two extremely unfavorable seasons, was 13.7 bushels per acre. This illustrates their extremely drought resistant quality. Page 327.

# Trials with Millets and Sorghums for Grain and Hay in South Dakota

— By —

A. N. HUME and MANLEY CHAMPLIN

(In Co-operation with United States Department of Agriculture, Bureau of Plant Industry)

## GENERAL INTRODUCTION

Under the climatic conditions prevalent in South Dakota, it is often desirable to include in the farming system certain crops that have the quality, or combination of qualities, that may be termed, for lack of better words, "drouth evasion." For this purpose the millets have their chief value. For example, if the cut-worms or early frosts ruin the corn, or hot winds and drouth destroy the wheat, oats or barley in June, the provident farmer may sow sufficient millet to furnish forage for his stock. This use of the millets is well understood by the public; but, that millet may be grown as a grain crop to furnish feed for poultry and to supplement the ration for growing stock and dairy cows, is not so well understood. In the season of 1911, when the feed problem was serious on many farms, a small investment in millet seed coupled with a few hours work in preparing the land might have produced a rank growth of roughage and a fair crop of rich grain.

A considerable amount of experimental work has been done by the Agronomy Department of the Experiment Station of the South Dakota State College of Agriculture and Mechanic Arts, in co-operation with the office of Grain Investigations of the United States Department of Agriculture, and it is believed that the present knowledge of the millets is sufficiently developed to warrant the presentation of the data obtained, considering not only the seed, but the soil, the preparation of the seed bed and the subsequent handling and utilization of the crop.

A specific factor which must be considered in South Dakota agriculture is the conservation of moisture. To conserve moisture satisfactorily it is necessary either to summer fallow, and thus lose the use of the land for one season, or to grow an intertilled crop.* The use of corn and potatoes in this relation is well understood, but the use of sorghum as an intercultivated crop for its beneficial effect upon the succeeding small grain crop has never been given very full consideration. The word sorghum usually carries with it the idea either of sugar cane and molasses or of a rank growing fodder crop. A rank growing fodder crop with a thick stand instead of conserving moisture, will exhaust it, and for this reason it must be clearly understood at the outset that the growing of sorghum for fodder is diametrically opposite to the growing of certain sorghums for grain, which is the subject treated in the second section of this paper. The co-operative investigations with the grain sorghums reported in this bulletin have been carried on since 1909, and it is now recommended that these crops be given more consideration than in the past, particularly in the western portion of the state, not with the idea of displacing corn, but for the sake of increasing the acreage of intertilled crops and further diversifying the cropping systems.

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# MILLETS

The various kinds of millets have been grown in nearly all parts of Europe and Asia for many centuries. Their food value is well recognized. The seed is made into cakes and gruels for human consumption while the straw or roughage serves as provender for live stock. It is natural to suppose that, owing to the wide distribution of the millet crop, certain species or strains would prove best adapted to one region while others would give best results elsewhere. It is doubtless for this reason that the names in common use for the different varieties have geographical significance, as German millet, Hungarian grass, Russian millet or Siberian millet. The name millet comes from the

*Refer to South Dakota Bulletin, No. 124, Willis and Champlin, pp. 33, 36, 41, table showing effect on small grain of previous cultivated crop combined with good seed.

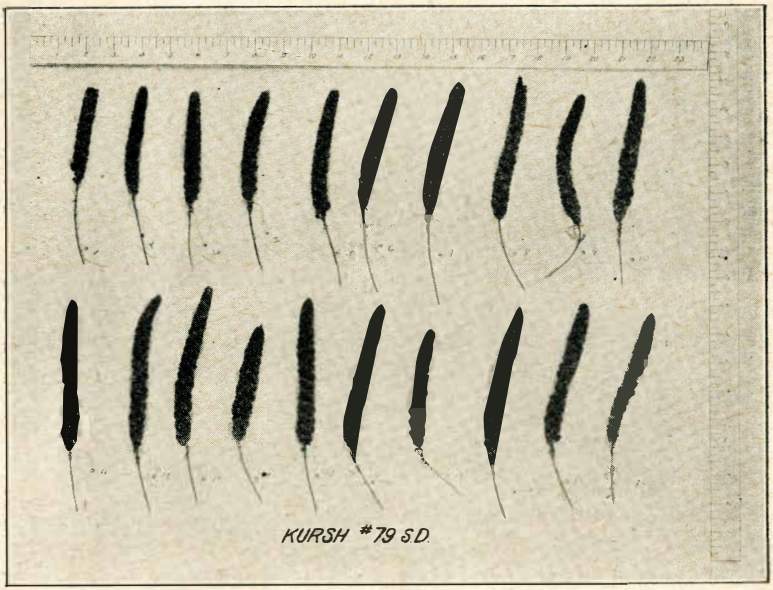


Figure 1.

Kursk No. 79 Foxtail Millet, the orange-seeded Kursk. These heads were used as mothers in the millet-breeding nursery.

same Latin word from which the English word million is derived and refers to the great number of seeds per head. As has been found true of several other crops, those millets which come from eastern Russia and Siberia are apparently well adapted to South Dakota conditions.

## KINDS OF MILLETS

The millets all belong to the the grass family (Gramineae.) There are two principal divisions; the proso, commonly called broom corn or hog millet. (Panicum miliaceum) and the foxtails or hay millets (Chaetochloa Italica).

The prosos may be known by their spreading or *panicled* heads, wide, hairy leaves and large seed. The foxtails resemble very closely the common foxtail or pigeon grass. The varieties which have been tested at Highmore include those which are supposed to be adapted to this state and may be classified as follows:

I. Proso Type.
  A. Spreading Heads.
    1. Red Seed.
      (a) Turghai G. I. No. 31.
      (b) Red Russian G. I. No. 11.
      (c) Tambov G. I. No. 13.
      (d) Red Voronezh G. I. No. 60.
    2. Black Seed.
      (a) Black Voronezh G. I. No. 16.
  B. Compact Heads.
    1. Red Seed.
      (a) Early Fortune G. I. No. 23.
      (b) Red Orenburg G. I. No. 15.
      (c) Red Lump G. I. No. 65.
    2. White Seed.
      (a) White Ural G. I. No. 4.

II. Foxtail Type.
    1. Orange Seed.
      (a) Kursk No. 79.
    2. Light Colored Seed.
      (a) Kursk No. 78.
      (b) German.
      (c) Common.

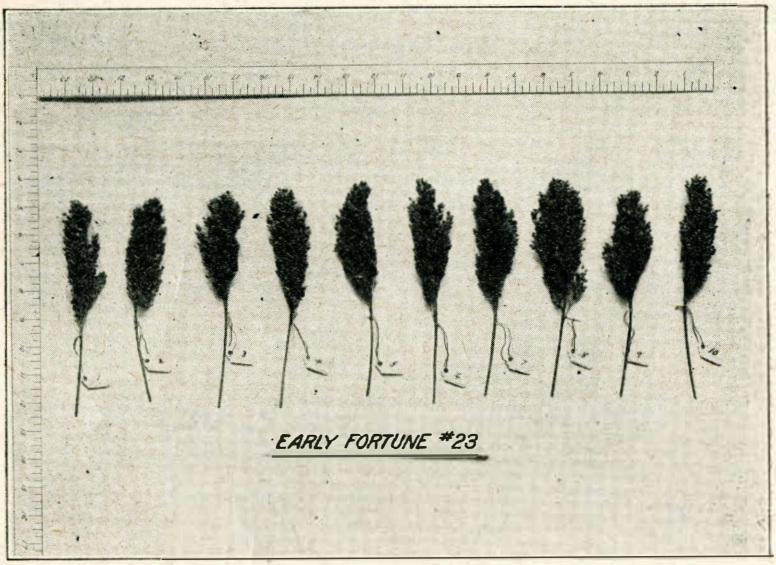


Figure 2.

Early Fortune No. 23 Proso Millet, illustrating the compact headed type of the prosos. One of the earliest introductions.

(d) Hungarian.

3. Mixed, Orange and Light Colored Seed.
   (a) Kursk No. 80.
   (b) Siberian.

With the exception of German, Hungarian and Common, all of these varieties were introduced from East Central Russia and Siberia by the Bureau of Plant Industry, United States Department of Agriculture. When these introductions were made, the varieties were usually named after the locality from which they came. For example, both Red and Black Voronezh came from the Province of Voronezh; Kursk No. 80 came from the Province of Kursk; and the other Kursk numbers, 78 and 79 were separated according to seed color by W. A. Wheeler, formerly of the South Dakota State College Agriculture Experiment Station.

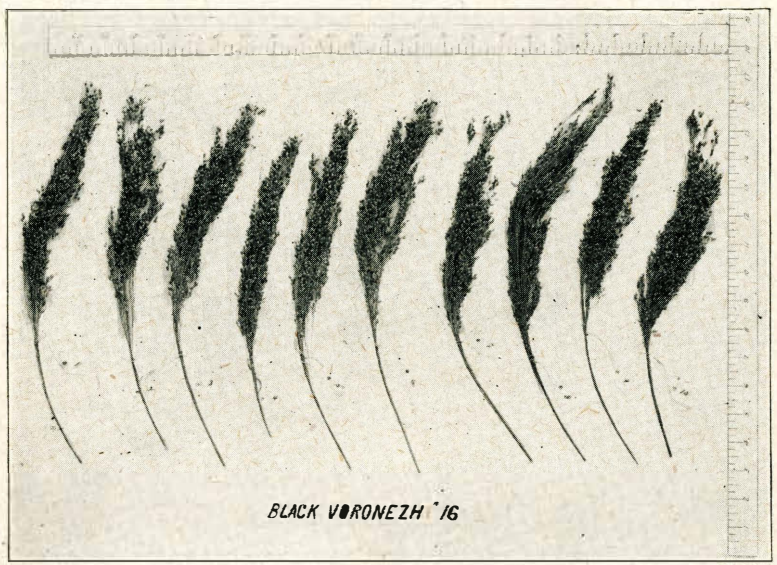


Figure 3.

Black Voronezh No. 16 Proso Millet, illustrating the spreading headed type of proso. This variety has proved to be one of the best.

## VALUE OF VARIETIES

Tests of varieties of millet were begun in 1903 and have been conducted with more or less regularity since that time. New varieties have been obtained and added to the test from time to time. Table I, which follows, shows the yields of grain obtained from each variety for each year grown.

**TABLE I.**

**Yield of Grain in Bushels per Acre from Varieties of Millet 1903-1911**

| Proso Varieites | G. I. No. | 1903 | a 1904 | 1905 | 1906 | 1907 | a 1908 | 1909 | 1910 | b 1911 | No. Years Grown | Av. for all Years Grown | Av. 1907-1910 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Black Voronezh | 16 | .... | .... | 33.7 | 35.4 | 22.5 | .... | 20.4 | 5.0 | 0 | 6 | 19.5 | **16.0** |
| Tambov | 13 | .... | .... | .... | 43.3 | 27.1 | .... | 12.8 | 7.0 | 0 | 5 | 18.0 | **15.6** |
| Early Fortune | 23 | .... | .... | .... | .... | 20.4 | .... | 22.0 | 3.4 | 0 | 4 | 11.5 | **15.3** |
| Red Turghai | 31 | .... | .... | .... | 38.7 | 20.8 | .... | 18.0 | 5.0 | 0 | 5 | 16.5 | 14.6 |
| White Ural | 4 | .... | .... | .... | .... | 24.2 | .... | 14.4 | 2.0 | 0 | 4 | 10.2 | 13.5 |
| Red Russian | 6 | 22.2 | .... | 42.3 | 40.4 | 19.6 | .... | 16.8 | 1.8 | 0 | 7 | 20.4 | 12.7 |
| Red Orenburg | 7 | 22.8 | .... | 21.8 | 32.2 | 14.5 | .... | 20.0 | 1.6 | 0 | 7 | 18.8 | 12.0 |
| Averages | .. | 22.5 | .... | 32.6 | 37.4 | 21.3 | .... | 17.8 | 3.7 | 0 | . | 16.4 | 14.2 |
| Foxtail Varieties | | | | | | | | | | | Av. 1906-1910 | | Av. 1907-1910 |
| Common | .. | .... | .... | 52.7 | 27.3 | 35.9 | .... | 11.2 | 5.6 | 0 | 20.0 | 22.1 | **17.6** |
| Kursk. S. D. 80 | .. | .... | .... | .... | 42.6 | 28.3 | .... | 18.0 | 1.4 | . | 22.6 | 22.6 | 15.9 |
| Kursk, S. D. 78 | .. | .... | .... | 54.2 | 37.9 | 30.7 | .... | 15.2 | 1.4 | 0 | 21.3 | 23.2 | 15.8 |
| Kursk. S. D. 79 | .. | .... | .... | .... | 32.9 | 32.0 | .... | 14.2 | 0 | 0 | 19.8 | 15.8 | 15.4 |
| Hungarian | .. | .... | .... | .... | 38.7 | 24.0 | .... | 13.6 | 0 | . | 19.1 | 19.1 | 12.5 |
| Siberian | .. | .... | .... | 53.0 | 31.2 | 22.1 | .... | 14.4 | 0 | . | 16.9 | 24.1 | 12.2 |
| German | .. | .... | .... | 53.0 | 21.2 | 22.1 | .... | 11.6 | 0 | . | 17.8 | 17.8 | 11.5 |
| Averages | .. | .... | .... | .... | 36.7 | 22.9 | .... | 14.0 | 1.2 | 0 | 19.6 | 20.7 | 14.4 |

a. No record for this year.
b. Failure due to hot winds in June. Not replanted.

## CONCLUSIONS FROM TABLE I

*1. Proso Millets.*

From the comparable three-year averages given in the last column of Table I, it is apparent that the highest average yields of grain from Proso varieties were made by Black Voronezh, No. 16, and Tambov, No. 13.

Moreover, among the several varieties tested during the years 1905-1911, one or the other of these two named have always given the highest yield of grain, with the one exception of the year 1905. In that year Red Russian yielded higher than Black Voronezh, Tambov being not in the test that year. It should be here explained that Red Russian is botanically the same as Tambov.

It is fair to say that Table I indicates that the highest yielding varieties for grain among the Proso varieties in this test are *Black Voronezh* and *Tambov*.

2. *Foxtail Millets.*

The three varieties of foxtail millet, which gave the highest average yields for the comparable years 1906–1910 were in order, Kursk (S. D. No. 80), Kursk (S. D. No. 78) and Common. It may be recalled that the two Kursk varieties are very similar, differing mainly in color of seed.

Moreover, in every separate year of the test one or the other of these varieties, yielded highest among the several varieties of foxtail millet tested.

It seems therefore reasonable to say that Table I indicates that when yields of grain are desired from foxtail millets, the most promising varieties are the ones just mentioned.

## COMPARISON OF GRAIN YIELDS FROM PROSO AND FOXTAIL TYPES

In order to secure a direct comparison of average yields of grain, from the Proso millets and the Foxtail Millets, the average yields of the several varieties for the years 1907–1910 should be consulted. These were the years in which all the varieties in the test of Table I were grown. The averages in question are to be found in the last column of Table I.

The highest average yield of grain made by any variety in the years 1907–10 was 17.6 bushels. This was the yield of Common millet, a foxtail variety. This highest average, however, is in part due to the outstanding high yield of Common millet for 1907, which appears to have been accidental, if one judge by comparing it with other yields. The next highest average yield among all varieties for 1907–10 was 16.0 from Black Voronezh. The yields of Kursk (S. D. 80), Kursk (S. D. 78) and Tambov, were practically the same.

*In short, the two highest yielding Proso varieties, and the three highest yielding Foxtail varieties showed no essential differences when compared as to yields of grain.*

Apparently, therefore, if one of these five varieties is to be given preference over the others in crop production, it must be done upon some other basis than yield of grain.

In the following Table II, are recorded the results of the single-year tests of several foxtail varieties for forage production. The yields of hay per acre are put down in hundred weights.

**TABLE II**

**Yields of Hay in Hundred Weights, per Acre from Varieties of Foxtail Millet 1910**

| Variety | Cwt. of Forage | Compared by Per Cent | Lines Show Comparative Value |
|---|---|---|---|
| Kursk No. 78 | 42.5 | 100 | |
| Kursk No. 79 | 35.0 | 82 | |
| Kursk No. 80 | 30.0 | 71 | |
| Siberian | 18.0 | 42 | |
| German | 15.5 | 36 | |
| Hungarian | 15.0 | 35 | |
| Common | 14.5 | 34 | |

Table II is self-explanatory. The results of a single year are not conclusive. The thing which may be said is that in the dry season of 1910, Kursk millets gave the highest yields of hay among foxtail varieties tried. This is in the line of substantiating the conclusion that these are among the most promising of all varieties of millet either for grain or hay.

## GENERAL CONCLUSIONS FROM TABLE I

It is important to note that the average of the highest yields of *Kursk millet for all seasons of this test was 24.7 bushels of grain per acre,* almost the same as the average yield of corn for the entire state.

Moreover, the general fact remains that in untoward seasons when millet, for grain, is severely injured, as it was in the years 1910 and 1911 at Highmore, Kursk millet may still be usually harvested for hay, as was done in 1910. In that year the yields of hay were profitable.

The average of the highest yields of grain, of Kursk millet for the favorable seasons, 1905–1909 (omitting 1908) was 36.7 bushels.

*The facts apparently warrant the increased use of Kursk Millet, as a grain crop in South Dakota.*

## GROWING THE CROP

As has been said, one of the principal values of the millets lies in their short maturing period, making them available for "catch" or supplementary crops. In 1910 the prosos grown from selected seed ripened in eighty days from the time they were planted. The foxtails require about ten days longer to mature seed than the prosos.

In growing the crop, there are four important phases of the work to be given attention. These are·

1. Soil and soil preparation.
2. Seeding, rate and date.
3. Harvesting and seed selection.
4. Threshing.

Fortunately for the uses to which millet is best adapted, it will thrive on a great variety of *soils*. It has given paying returns on the glacial clay loam soil at the Highmore sub-station and on the glacial sandy loam at the Eureka sub-station, while on the "gumbo" or Pierre clay terrace formations at the Cottonwood sub-station, the millets, particularly Black Voronezh, have given the best returns of any crops which have been tried.

The *seed bed* should be plowed deep but should be well firmed or settled. As with other crops having small seed, it is of the greatest importance to put the seed in the ground at a uniform, and not too great a depth. In order to get the desired firmness, it may be necessary to use a roller, but ordinarily the spring rains will settle the ground sufficiently before time to seed millet. In this case, all the preparation that is necessary other than plowing is a thorough disking, using care to set the disk rather shallow and to avoid ridging the land by lapping half at each round. The purpose of disking is to firm the subsurface of the seed bed and to mellow the surface. This purpose may be attained if care is used in setting the disk.

After the land has been thoroughly disked, the drag may render the surface fine and even. A lever drag should be used

and the teeth set at an angle of about forty-five degrees. This will make the drag work on the surface without disturbing the sub-surface.

## RATE AND METHOD OF SEEDING

The rate and method of seeding which have been found to give very good results are as follows: When seed is desired as the main crop, with forage incidental, the seed may be sown with an ordinary disk drill in drills one foot apart, using one peck of seed per acre. In order to sow the foxtails at this rate, the ordinary grain drill must be given its finest adjustment and every alternate hole either plugged or covered. The proso millets have larger seed than the foxtails and the usual adjustment for two pecks of flax seed on most drills will give the desired one peck per acre of proso when every alternate hole is covered.

When forage is especially desired, this rate of seeding is doubled and the drill rows are sown six inches apart, the same as wheat.

It is also possible that later experiments will demonstrate the wisdom of drilling millet for grain in rows more than one foot apart, in order to allow more complete cultivation.

The best date for seeding millet will depend upon the conditions. A high germination temperature is required and for that reason there is apparently little gained by sowing earlier than June 1st. But since the object in growing millet is ofttimes to use land where some other crop has failed, it may be necessary to delay sowing until as late as July 1st. If the rainfall in the latter part of the season is heavy, the late seeding will be satisfactory. It will be readily seen, however, that a slightly earlier seeding, say, June 15th, would be more likely to give best results, since it would have a better chance for favorable moisture conditions than the late seeding, and more favorable germination temperature than the early seeding.

After the millet has come up and established a secure roo system, one or two cultivations with a spring tooth weeder may be found very beneficial.

## WHEN TO HARVEST

It is often difficult for the inexperienced millet grower to tell when to harvest the crop for grain. This is particularly

true of the prosos. With millet of this type, the upper part of the head often ripens and begins to shatter while the remainder of the head appears quite green. Moreover, in the prosos, the chaff may remain green after the seed is entirely ripe. By examining the head, however, and shelling out a part of the seed, the grower can form a good idea as to when the grain crop is ready to cut. There is a tendency for the seed to ripen in the shock if cut a little green so that all in all it is better to cut a ittle early than a little late. It is usually best to cut the proso millet when it appears to be about half ripe. In the case of the foxtails there is little trouble from shattering until the crop is dead ripe.

## MAKE HEAD SELECTIONS FOR SEED

Another matter that should receive attention at harvest time is the selection of the best heads for seed for the following year. This requires comparatively little time and millet is susceptible to improvement by selection. The large, well-formed heads may be cut off by hand with an ordinary pocket knife. A short stem should be left on each head to permit of tying in bundles so that they may be hung up to dry. To emphasize the importance of making these head selections for seed, it may be well to call attention to the results of some work at Highmore Sub-station. In 1909 the finest looking heads of each variety of proso were selected for the purpose of sowing seed plots. In 1910 these seed plots were sown from the selected seed in order to increase the selected stock. The variety test plots were sown as usual with bulk seed out of the main crop. The experiment did not at first contemplate comparing the results obtained by using selected as against bulk seed. It was simply desired to increase the selected lots. But the soil on which the seed plots were grown was similar, so that the results are reasonably comparable, although the dates of seeding and sizes of plots were different.

**TABLE III.**

**Yields of Proso Millet Per Acre in 1910 from Head-selected Seed, as Compared with that from Bulk Seed at Highmore**

| Variety | Selected Seed | | | | Bulk Seed | | | |
|---|---|---|---|---|---|---|---|---|
| | Height inches | Length of Head | Yield Grain Bushels | Yield Cwt. Straw | Height inches | Length of Head | Yield Grain Bushels | Yield Cwt. Straw |
| Black Voronezh | 36 | 10 | 9 | 27.5 | 32.0 | 9.0 | 5.0 | 13.5 |
| Tambov | 28 | 9 | 8 | 14.0 | 25.0 | 8.0 | 7.0 | 12.0 |
| Early Fortune | 22 | 4 | 7 | 8.5 | 26.0 | 3.5 | 3.4 | 8.3 |
| Red Turghai | 25 | 9 | 13 | 25.5 | 26.0 | 8.0 | 5.0 | 7.5 |
| White Ural | 21 | 5 | 4 | 14.0 | 23.0 | 4.0 | 2.0 | 9.5 |
| Red Russian | 28 | 9 | 10 | 13.0 | 23.0 | 7.0 | 1.8 | 14.1 |
| Red Orenburg | 26 | 4 | 7 | 9.5 | 25.0 | 3.5 | 1.6 | 12.2 |
| Averages | 26.6 | 7.1 | 8.3 | 16.0 | 25.7 | 6.1 | 3.7 | 11.0 |

By reference to Table III, it will be seen that in all cases the yield of grain was greater for the selected seed and that as an average of all varieties the yield of grain from the bulk seed was less than one-half of that from the selected seed.

It may be further noted that in all cases, the average length of heads on the plots from selected seed was greater than the average length of heads on plots from bulk seed, that the average yield of straw for all varieties from selected seed was nearly one and one-half times as great as that of all varieties from bulk seed and that the average height was greater for the selected seed plots.

## THRESHING

The threshing of the bulk crop can be handled withou difficulty by the usual custom method of threshing, the same as with other grains, but an effort should be made to thresh the millet as soon as it has dried thoroughly in the shock instead of stacking it. On account of its tendency to shatter, the millet should not be handled any more than is necessary between harvesting and threshing.

## USES AND QUALITY OF MILLET

Aside from the market demand for the seed crop, which often exceeds the supply, the grain of millet has a very definite value as a feed. The per cent of protein, one of the important

feeding constituents contained therein, is comparatively high, (See Table 8). For this reason instead of being fed as an exclusive concentrate, millet is often used as a supplementary feed to be mixed with other feed.

Owing to the tough seed coats possessed by both foxtail and proso millet seeds, it is customary, either to grind or soak the seed before feeding to live stock. For poultry this grinding is not necessary.

Definite information concerning the chemical quality of the grain of various varieties of millet is furnished in the following tables:

**TABLE IV**

**Analyses of Proso Millets (Grain) Grown at Highmore, South Dakota, 1909**

| Variety | G. I. No. | Water | Ash | N×6.25 Protein | Fat | Fiber | Starch* Etc. | Weight of seeds per 1000 grams |
|---|---|---|---|---|---|---|---|---|
| White Ural | 4 | 10.24 | 2.30 | 12.94 | 3.95 | 2.57 | 68.00 | 2.89 |
| Red Russian | 11 | 9.81 | 2.78 | 11.75 | 4.00 | 6.17 | 65.49 | 4.85 |
| Tambov | 13 | 9.88 | 2.75 | 11.69 | 4.13 | 5.84 | 65.71 | 4.91 |
| Black Voronezh | 16 | 10.00 | 2.29 | 10.81 | 3.83 | 5.50 | 67.57 | 5.03 |
| Red Orenburg | 15 | 9.85 | 2.34 | 11.06 | 3.50 | 5.56 | 67.69 | 6.18 |
| Red Turghai | 31 | 9.89 | 2.84 | 12.69 | 4.29 | 5.83 | 64.36 | 4.76 |
| Early Fortune | 23 | 9.68 | 2.50 | 13.75 | 3.68 | 6.76 | 63.63 | 6.22 |
| Averages | .. | 9.91 | 2.56 | 12.09 | 3.91 | 5.43 | 66.10 | 4.98 |

Table IV indicates the generally high content of protein, fat and fibre, in millet grain, and the correspondingly low content of starches and carbohydrates.

In view of the fact also that the foxtails, especially Kursk, have been shown to make high yields per acre, it is the more interesting to compare the per cents of protein. The average per cent of protein for Proso millets in Table IV is 12.09, while for foxtails it is 13.77. The foxtails have also slightly the higher percentage of fat. This is an additional indication corroborating a previous statement that *Kursk millets*, which are of the foxtail type, are to be recommended as promising.

*Obtained by difference.

## TAELE V

### Analyses of Foxtail Millet (Grain) Grown at Highmore, South Dakota, 1909

| Variety | Water | Ash | Nx6.25 Protein | Fat | Fiber | Starch* Etc. | Weight of Seeds per 1000 grams |
|---|---|---|---|---|---|---|---|
| Kursk No. 78 S. D... | 9.14 | 3.16 | 14.12 | 3.98 | 7.46 | 61.14 | 2.07 |
| Kursk No. 79 S. D... | 10.92 | 3.25 | 13.20 | 4.01 | 7.96 | 61.66 | 1.87 |
| Kursk No. 80 S. D... | 9.18 | 3.24 | 13.00 | 4.21 | 7.69 | 61.68 | 2.11 |
| Common ..... | 9.03 | 3.52 | 13.94 | 4.19 | 6.97 | 62.35 | 1.74 |
| Hungarian ..... | 10.86 | 4.01 | 14.37 | 4.89 | 7.70 | 59.17 | 1.64 |
| Siberian ..... | 9.83 | 3.97 | 12.81 | 4.01 | 10.26 | 59.12 | 1.80 |
| German ..... | 9.69 | 4.16 | 14.75 | 4.33 | 9.53 | 57.54 | 1.38 |
| Averages ..... | 9.81 | 3.63 | 13.77 | 4.23 | 8.22 | 60.38 | 1.80 |

*Obtained by difference.

# GRAIN SORGHUMS

## INTRODUCTION

Under the term, grain sorghums, it is customary to include such species of the nonsaccharine sorghum group as are of more value for their seed than for their fodder. These include Kafir, milo, durra or Egyptian corn and the kowliangs. These have all been used to some extent in various parts of the United States. It would seem that their culture was found unprofitable as compared with corn in those regions where rainfall is ample, for there are occasional records from such regions, of introductions which were tried and finally discarded. With the settlement of the high plains of western Kansas, eastern Colorado and the Pan Handle region of Texas and Oklahoma; milo and kafir early became dependable crops for farmers in those sections. It was found that these grain sorghums withstood drought and excessive heat without as serious injury as maize, and that on the other hand, when moisture conditions were favorable, the crops made comparatively good yields. There were numerous objections to both kafir and milo as they were originally introduced. They were too tall for convenient handling by machinery. They ripened unevenly and in the case of milo, the heads on many of the stalks tended to bend over, forming what is known as a "goose neck". This too, interfered with machine handling. Fortunately the grain sorghums are susceptible to improvement by selection and the experiment stations, aided by the United States Department of Agriculture and the farmers themselves, have succeeded in securing varieties of both kafir and milo that are dwarfed in stature and uniform in time of maturity.

The gooseneck head is still found occasionally in the milo, but it too, is rapidly being eliminated from the selected varieties. Since the kafir and milo proved themselves of such importance to agriculture in the southern and central portion of the Great Plains area, it was desirable to learn whether or not there were any varieties that would mature early enough for the northern part of the plains, including western South Dakota.

With this object in view, the United States Department of Agriculture, through its agents and agricultural explorers, obtained seed of very hardy varieties of a new group of grain sorghum grown in Manchuria and North China. This form is known in China as "kao-liang" meaning tall millet. The name, as adopted by the United States Department of Agriculture, has been given the spelling, *Kowliang*. In its native country this crop is put to a multitude of uses: the grain for human and animal food and for distilling a spirituous liquor; the leaves as forage for cattle; the stalks for erecting buildings, fences, etc., for manufacturing matting and for fodder. The natives expect to secure average yields of about twenty bushels of seed and from one to one and one-half tons of fodder per acre. They consider it their most valuable forage crop. There are certain varieties of kowliang that grow very tall. It is said that during the Russo-Japanese war, entire armies were able to maneuver unseen in the fields of kowliang. Its main advantages as a "dry land" crop may be summed up as follows:

(1) Drought resistance, that is, low water requirement with ability to make good yields in dry years. (2) Early maturity. (3) Production of a single stalk from a single seed.

## VARIETIES OF GRAIN SORGHUM

In 1909 a number of varieties and species of grain sorghum were placed on trial at the Highmore Sub-station. These included three varieties of brown kowliang, one of black-hulled kowliang, two of milo and two selections from a "cross" between kafir and durra. The first season's work was sufficient to show very clearly that neither milo, the black hulled kowliang, nor the kafir-durra crosses can be matured under the conditions prevailing in central South Dakota, with any degree of certainty. It may be possible in time to shorten the growing period by selection of the few heads that do ripen seed each year. By this means, subsequent results have shown that it is very probable that varieties may be developed which will mature seed in the south half of the state.

Head selections have been made each year from the most promising strains of milo and of kafir-durra hybrid. In the season of 1911, the main crop of kafir-durra matured and the milo headed uniformly and was nearly mature at harvest time.

In the following table may be seen the results of some trials, showing periods of time that are necessary for maturity and the yields in bushels of grain per acre, of several varieties and strains of grain sorghum. The trials were made at Highmore in the three years, 1909, 1910 and 1911.

**TABLE VI**

**GRAIN SORGHUMS**

**Average Yields of Grain, 1909-1911**

| Variety | G. I. No. | H. No. | 1909 | | 1910 | | 1911 | | Average Days to Mature | Bu. per acre |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Days* to Mature | Bu. per acre | Days* to Mature | Bu. per acre | Days* to Mature | Bu. per acre | | |
| Brown Kowliang ... | 171-8 | 92 | 117 | 14.8 | 116 | 19.2 | ... | .... | ... | .... |
| Brown Kowliang ... | 261-4 | 91 | 114 | 14.0 | 114 | 20.0 | ... | .... | ... | .... |
| Brown Kowliang ... | 328 | 90 | 114 | 14.8 | 110 | 16.4 | ... | .... | ... | .... |
| Brown Kowliang ... | 171-8 | 289 | ... | .... | ... | .... | 109 | 10.3 | 114 | 14.8 |
| Brown Kowliang ... | 261-4 | 290 | ... | .... | ... | .... | 105 | 6.0 | 111 | 13.3 |
| Brown Kowliang ... | 328 | 291 | ... | .... | ... | .... | 105 | 8.2 | 110 | 13.1 |
| Brown Kowliang ... | 424 | 94 | ... | .... | ... | .... | 114 | 11.0 | ... | .... |
| Black Hull Kowliang | 310 | .. | ... | 2.4 | ... | .... | ... | .... | ... | .... |
| Kaffir-Durra ..... | 198-15-3 | 89 | 146 | 10.8 | Failed | .... | 134 | 15.0 | ... | 8.2 |
| Milo ..... | 234 | 88 | 145x | 10.0 | Failed | .... | 144x | 4.7 | .... | 4.9 |
| Dwarf Milo ..... | 332 | 322 | ... | .... | ... | .... | 144 | 10.7 | ... | .... |
| White Sorgo ..... | 350 | 319 | ... | .... | ... | .... | 114 | 11.0 | ... | .... |
| White Durra ..... | 81 | 320 | ... | .... | ... | .... | 129 | 12.0 | ... | .... |

*Between planting and ripening.
‡Sufficient heads ripened to make selections for seed.
x The main crop was not fully matured when harvested.

By reference to Table VI, it may be seen that in 1911 the selections from kafir-durra matured in 134 days as compared with 146 days required by the introduced seed in 1909. The Milo in 1909 was harvested 145 days after planting, while in 1911, an interval of 144 days elapsed between planting and harvesting. The crop was not fully ripe in either 1909 or 1911, but the 1911 crop was much more nearly so than that of 1909. There has been, therefore, some progress toward earlier maturity in the milo, altho the figures do not indicate it. There seems to be some hope that the kafir-durra selection may be worthy of trial in the south half of the state, but the milo is still not sufficiently well acclimated to warrant its use, even in that section. *For the present, milo must be considered an experimental crop in any portion of South Dakota.*

*By referring again to table VI, it will be seen that three brown kowliangs in 1909 gave a yield of about fourteen bushels per acre each.* Heads of a uniform, compact type were selected and grown in separate rows in 1910. The average yields from these selected rows of kowliang for the different varieties in 1910, which was one of the driest years since the settlement of the state, was from sixteen to twenty bushels, according to variety. In 1911, when the drouth was most serious

Figure 4.
Brown Kowliang No. 171, head rows, 1911, illustrating undesirable branching due to late rains. The late heads on the branches do not mature but take up nourishment that should go to the main head.

and all small grain crops were a total failure, the yields of kowliang varied from six to eleven bushels per acre. The average yield of grain per acre for three strains of Kowliang for three years, including two extremely unfavorable seasons, was 13.7 bushels per acre. It can not be said that the yield was a very profitable one. It indicates, however, the extremely drought resistant character of the kowliangs. In the spring of 1911, a considerable distribution of kowliang seed

was made in small lots to several farmers who were willing to give the new crop a trial. One of these trials was made by Mr. G. Knickerbocker, of Eureka, McPherson County. In that locality the drouth was so protracted that the corn crop was a failure. The three rows of kowliang, however, in a garden well cultivated, produced an average yield of 9.8 bushels per acre.

For the purpose of obtaining a comparison between brown

Figure 5. Kafir-Durra Hybrid.

A crop which may prove valuable in the south central and south western part of the state. It requires a longer period to mature than Brown Kowliang but is more desirable as a forage and grain combination crop.

kowliang and corn, Table VII has been compiled, which shows comparative yields of different varieties of kowliang and of corn for the years 1909, 1910 and 1911 at the Highmore Substation.

Figure 6.

Minn. No. 13 Corn under the same climatic conditions as the Kafir-Durra and Brown Kowliang in previous figures, showing superiority of the grain sorghums under extreme conditions.

**TABLE VII**

**Brown Kowliangs and Corn Comparing Average Yields of Grain 1909, 1910, 1911. (Figures=bushels per acre.)**

| Variety | G. I. No. | 1909 | | 1910 | | 1911 | | Average | |
|---|---|---|---|---|---|---|---|---|---|
| | | Kowliang | Corn | Kowliang | Corn | Kowliang | Corn | Kowliang | Corn |
| Brown Kowliang ... | 171-8 | 14.8 | .... | 19.2 | .... | 10.3 | .... | 14.8 | .... |
| Brown Kowliang ... | 261-4 | 14.0 | .... | 20.0 | .... | 6.0 | .... | 13.3 | .... |
| Brown Kowliang ... | 328 | 14.8 | .... | 16.4 | .... | 8.2 | .... | 13.1 | .... |
| Brown Kowliang ... | 424 | .... | .... | .... | .... | 11.0 | .... | .... | .... |
| Minnesota 13 ..... | ..... | .... | 13.8 | .... | 7.5 | .... | 15.5 | .... | 12.3 |
| Brown County ..... | ..... | .... | .... | .... | 9.7 | .... | 6.8 | .... | 8.3 |
| U. S. No. 133 ..... | ..... | .... | 20.3 | .... | .... | .... | 12.0 | .... | 16.2 |
| Corn Palace ..... | ..... | .... | .... | .... | .... | .... | 14.1 | .... | .... |
| Averages ..... | ..... | 14.5 | 17.1 | 18.5 | 8.6 | 8.9 | 12.1 | 13.7 | 12.3 |
| Protein in lbs per acre ..... | ..... | 96.4 | 100.6 | 123.0 | 50.6 | 59.2 | 71.2 | 91.1 | 72.4 |

* See Table 8 for Analyses.

From Table VII, it will be seen that Brown Kowliang No. 171-8 has averaged 2.5 more bushels per acre for the three

years than Minnesota No. 13 corn, which is a standard variety, and that the average yield of all varieties of kowliang for all years grown, is 1.4 bushels per acre higher than the average yield of all varieties of corn for all years grown. An added line below in the table shows that the average yields of protein per acre correspond to the weights of grains, The amounts of protein are calculated from the analyses shown in Table VIII.

## GRAIN SORGHUM.—USES OF THE CROP.

As was stated, the kowliangs are recent introductions from Manchuria and northern China where they are considered one of the most important crops. Manchuria lies approximately between 44° and 52° north latitude. South Dakota lies approximately between 43° and 46° north latitude. In some respects, the climates of the two regions are similar. As has been found with a number of other crops introduced into this state, those grain sorghums which come from a region of similar climate in Asia, have shown good results from the beginning. *In this state, however, if further experiments shall demonstrate that grain sorghums are a profitable crop for large areas, their leading value will be their use as supplementary feeds for live stock or as a maintenance ration when other feed is lacking.*

In the following table are analyses of Brown Kowliang for comparison with some commoner crops, used for feed.

**TABLE VIII**

**Analyses of Brown Kowliang Compared with Millet, Corn, Barley, Oats and Wheat.***

| Variety | Water | Ash | Protein | Fat | Fiber | Starch etc. | No. of Samples |
|---|---|---|---|---|---|---|---|
| Brown Kowliang 328..... | 9.41 | 1.83 | 13.7 | 4.57 | 1.43 | 69.06 | 2 |
| Brown Kowliang 261-4..... | 8.15 | 1.74 | 13.7 | 4.86 | 1.56 | 69.99 | 2 |
| Brown Kowliang 171-8..... | 8.86 | 1.73 | 12.4 | 4.36 | 1.51 | 71.14 | 2 |
| Foxtail Millet ..... | 9.81 | 3.63 | 13.77 | 4.23 | 8.22 | 60.38 | 14 |
| Proso Millet ..... | 9.91 | 2.56 | 12.09 | 3.91 | 5.43 | 66.10 | 14 |
| Corn ..... | 10.9 | 1.51 | 10.51 | 5.44 | 2.05 | 69.59 | 208 |
| Wheat ..... | 10.5 | 1.79 | 11.99 | 2.06 | 1.79 | 71.87 | 310 |
| Oats ..... | 11.0 | 2.94 | 11.84 | 4.98 | 9.52 | 59.72 | 30 |
| Barley ..... | 10.9 | 2.41 | 12.47 | 1.78 | 2.67 | 69.77 | 10 |

* The figures in this table, relating to corn, wheat, oats and barley, were compiled from Table V, Farmers' Bulletin, 420, United States Department of Agriculture.

By referring to Table VIII, it will be seen that the kowliangs are higher in protein than corn, wheat or oats; that they do not contain quite as large a per cent of fat as corn or oats, but are higher in this respect than wheat or barley; that they are about equal to corn, wheat and barley, in starches and considerably higher than oats, and that there is practically no waste to the grain, the per cent of fiber being less than that of any of the common cereals.

While no data can be given as to the actual results obtained by feeding kowliang in comparison with the other common feed grains, the analyses shown in Table VIII, would indicate that the kowliang contains a very high per cent of nutrients and compares very favorably with oats and corn as a feed grain, being better for growing animals and work stock than corn, and better for fattening stock than oats. In other words, it would not be as good a feed for work stock as oats nor as good a feed for fattening stock as corn. It occupies an intermediate position.

As a feed for growing stock, it is preferable to grind or crack it and mix it with skimmed milk or water to be used as a 'soft ration." Where it is inconvenient for any reason to thresh the grain, it will be found practical to feed the heads to horses and cattle whole or to put the bundles directly into the feed rack or manger. This method, of course, is rather wasteful unless the residue can be picked over by poultry. There are circumstances when the latter method of feeding is advantageous. For example, if the moisture conditions or depth of planting in a field are uneven, so that it is impossible to secure a uniform crop of ripe grain, it will be best to cut the crop with a binder and feed it in the bundle. This situation occurred with one or two co-operating farmers the past season.

The fodder of kowliang is not as good feed as that of corn, there being fewer leaves in proportion to the total plant. The stalks are pithy and unpalatable when dry. Stock will get considerable feed value from the fodder, but if the supply of corn fodder is plentiful it is better to consider the kowliang as a grain crop and harvest the heads only. The fodder of the kafir-durra hybrid selection resembles the fodder of kafir corn and is in this respect more valuable than kowliang. Were it not for its lateness in maturing, the hybrid would be very promising as a fodder crop.

The kowliangs may have one very distinct value in the cropping systems of this state which has not been mentioned, namely: as a preparation for winter wheat. It is a well known fact that the principal difficulty in growing winter wheat is that the snow does not stay on the bare ground but piles up in drifts against anything that will stop it, leaving the summer-fallow and fall-plowed fields exposed to the action of high winds and changing temperatures. For this reason, it is becoming a common practice to drill the winter wheat in corn fields between the rows before the corn is ripe. As a preparation for winter wheat the advantage of kowliang is apparent. During the three years it has been grown at Highmore, it has always been planted on May 19th and has matured prior to September 15th. This permits the removal of the heads in time to sow winter wheat. The wheat can be sown with an ordinary drill

Figure 7.

Standard Milo, commonly called milo maize. While Milo has never fully matured a grain crop at Highmore, it has shown some gain in earliness through selection of the early heads and there is a possibility that it may be acclimated and prove valuable as far north as Mitchell.

among the headless stalks. The stalks left on the field will help catch the snow and protect the tender wheat plants. Since the above method has not been tried in this state through a long period, it should be considered as a suggestion rather than a conclusion drawn from long time experimental results.

In Japan, certain varieties of kowliang are grown as border crops to protect more tender crops from wind. In sections where winds are injurious to the grain crops, an occasional strip of kowliang may be of value in breaking the force of the surface sweep of the wind. This value was illustrated at the Highmore Sub-station during the present season. The millets in the field tests which were exposed to the full action of the winds were cut off at the crown by the flying particles of sand and grit, but a considerable portion of the millet plants in the breeding nursery, which was protected by a field of corn and grain sorghum on the south, survived the gale without injury.

## GROWING THE GRAIN SORGHUM CROP

Generally speaking, any soil well suited to the growing of corn is suitable for the growing of grain sorghums.

Figure 8.
A birds-eye view of the grain sorghum field, showing Dwarf Milo in the fore ground and Brown Kowliang in the back ground, September 8, 1911.

The seed bed should be prepared the same as is usual for corn, by deep plowing, disking and dragging. The seeding may be done any time between May 15th and June 10th. Too early seeding is not advisable because of danger from frost. The seed requires a rather high temperature for germination and if the planting is done to early, weeds will spring up and become a serious nuisance while the sorghum seed is lying in the ground. waiting for warmer weather. This is the leading difficulty in growing the crop and every precaution should be taken to have the seed bed free from weeds at planting time.

The planting may be done with an ordinary corn planter, using plates with small holes. These can be obtained by special order or by buying the blank planter plates and having holes drilled in them of the desired size. The usual thickness of planting for grain production, is one stalk for each six or eight inches of row with the rows forty-four inches apart. This requires about four pounds of seed per acre.

The cultivation of grain sorghums should be begun with a spring tooth weeder as soon as the young plants are about one inch high. Care should be taken to drive straight and to run the weeder in the same direction as the rows are drilled. Likewise, an ordinary "drag" or harrow can be used when considerable care is exercised, also running the harrow the same direction as the drill rows were planted. Crossing the drill rows with the harrow or weeder is not practicable until the plants are of some size and firmly rooted. One farmer cooperator destroyed his entire field of kowliang by cross dragging when the plants were young and tender.

Subsequent cultivation should be practiced in much the same manner as for corn, using the surface cultivator in alternation with the spring tooth weeder until the plants are too high for the weeder and then the cultivator alone until the crop is laid by.

## HARVESTING OF GRAIN SORGHUMS

There is no difficulty in determining when the crop is ripe as the seed itself may be readily inspected and when the seed. is nearly hard, the crop should be harvested. It is preferable to cut the grain sorghum with a corn binder and set the bundles in shocks to cure until ready for threshing. If no corn binder is available, an ordinary binder can be used. Still

another method is to use an ordinary grain header set as high as possible. The heads can be cured in small ricks or windrows, if the weather is reasonably dry. This method has the advantage of being cheap and rapid, and is probably the most practical on the average South Dakota farm, particularly when the fodder is not needed for feed. In small fields, the heads may be readily harvested by hand, thrown into a wagon box and ricked-up to cure, at about the same rate per day as corn can be husked. In regions where the grain sorghums form a principal crop, a machine known as a row header which is attached to the wagon box, is used on many farms.

## IMPORTANCE OF MAKING HEAD SELECTIONS FOR SEED.

Considerable attention should be given to the selection of the best heads for seed. There is a great deal of variation in the heads, some of them being rather open and light, others compact and heavy, and still others semi-compact and heavy. The heavy, compact heads should be selected from plants which are vigorous and as free as possible from suckers or side shoots. These suckers are objectionable, as they take away the nourishment from the main stalk and interfere with the full development of the head. There are comparatively few plants with suckers in the selected strains of kowliang and kafir-durra, so that these may be readily avoided when making the selections The seed heads may be tied in bunches and hung up to cure. Since it requires but four pounds of seed per acre, a comparatively small number of heads will be sufficient for seeding a considerable area.

The seed heads can be beaten out by hand without much difficulty. The bulk lot from the field can be threshed in an ordinary threshing machine with the concaves removed and boards substituted. This permits of running the entire bundle, fodder and all, through the machine, but it may be preferable to remove the heads from the fodder and thresh in an ordinary machine, merely adjusting the concaves properly. It is true that some of the grain will be cracked by the machine, but this does not injure its feeding value. If the grain from the bulk lot is desired for seed, the broken and cracked kernels may be quite thoroughly removed with a good fanning mill. This latter method is used in preparing the seed at the Highmore Sub-station.

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The data of this bulletin have been compiled and interpreted entirely by the writers.