

ity, as expressed by mortality, decreased in the inbreds both as young stock and in the laying pens.

Except for egg size in some lines, inbreeding has resulted in a decrease of most economic characteristics as compared with the outbred White Plymouth Rocks from which they were derived. It must be borne in mind that the value of the inbred chicken is not in the perform-

ance of the lines themselves but in how well they combine with other lines of inbreds or with outbreds. Further reports will give that information. This report is given to demonstrate the problems arising in producing inbred lines and some of the characteristics of the birds that resulted from continuous inbreeding.

Dr. Robert E. Moreng, formerly of this station and now at Colorado State University, assisted in a portion of the work on this project.

This progress report is the first of a series of three under Project H-14-1R.
Project partly supported by funds from Regional Project NC 47 (formerly NC8).

It's Hard To Beat!!

Sorghum for Forage

By J. F. Carter

Sorghum in North Dakota is a valuable silage or fodder crop when seeded about June 1, or about 2 weeks after corn planting time. Because it can produce a crop when planted as late as July 1, it has value as an emergency crop in years when flooded soil, late weed control, loss of a seeded crop, unusually dry soil, or any other reason makes very late seeding necessary. Sorghum also can be depended on to produce needed forage in times of feed shortage.

Forage sorghum, sometimes locally called "sugar cane", "cane" or "sorgo", is grown in the Great Plains area from Texas to North Dakota. The plant has a large, tall corn-like stem with conspicuous nodes or "joints", bearing broad leaves 2 to 3 feet long. A large panicle or "head" producing several hundred seeds

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is borne at the top of a 4 to 9 foot stalk. The stem is often very juicy, and sweet as it contains soluble sugars. The leaves and stems are palatable to livestock.

The root system is fibrous and extensive. The plant uses water efficiently in producing plant material. Sorghum is drouth resistant and can survive drouth periods in a somewhat dormant condition and resume growth later without great plant damage as occurs with corn or many other plants. Sorghum is a heat-loving plant and grows best in a warm, fertile soil with a good moisture supply. Seeding should be delayed until the soil and air temperatures are warmer than those for corn. The plant is killed by the first severe frost in the fall, but the leaves appear to dry more slowly and shatter less easily after frost than corn. Cold night temperatures probably con-

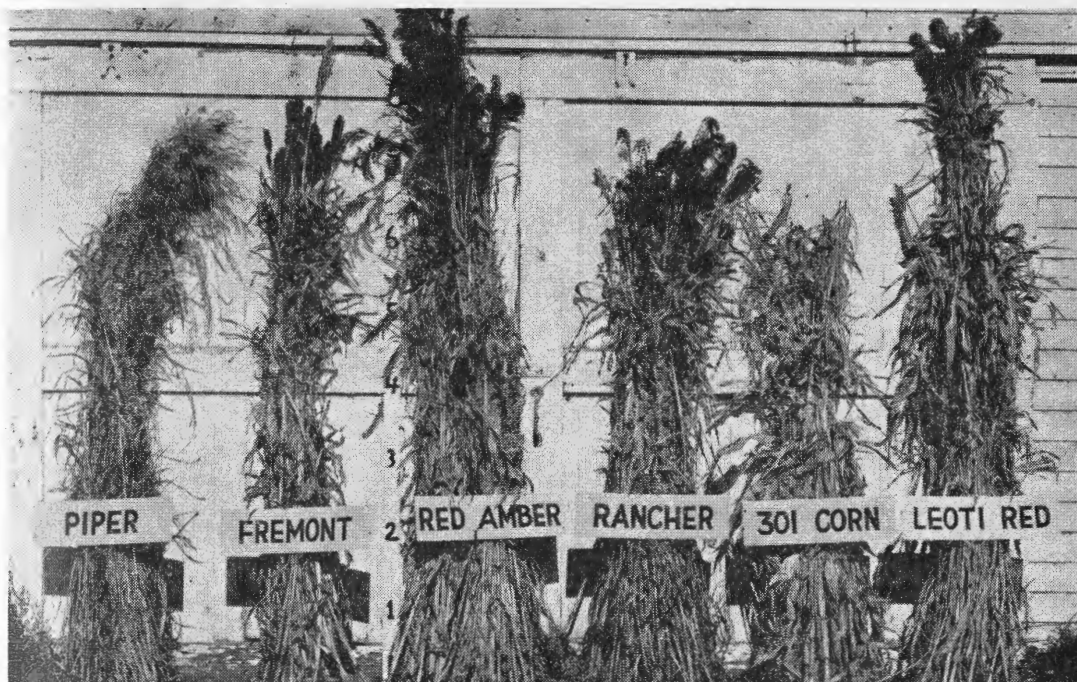


Fig. 1. Bundles from 2-foot cultivated rows in which Leoti Red and Rancher produced 22 tons of silage; Fremont and Red Amber, 20 tons; Piper sudan, 17 tons; and Nodak 301 corn, 15 tons an acre in June 1 seeding, 1957, Fargo.

tribute to slow growth of sorghum at high altitudes of western North Dakota.

Only one disease, bacterial leaf spot, *Pseudomonas syringae*, appears to injure sorghum in North Dakota. Some varieties, such as Leoti Red, are resistant to it.

No insect seriously damages sorghum in North Dakota to date, though aphids have been observed in the top leaf whorl of the sweeter, juicy-stemmed varieties, and can cause pollination difficulty. Sorghum is more resistant to grasshopper damage than corn, and is not subject to loss of silks and seed from grasshopper damage as is corn. Forage sorghum has not been damaged by corn borer at Fargo, where borer damage to corn has occurred.

Sorghum contains larger amounts of prussic acid (HCN or hydrocyanic acid) than sudangrass. The HCN content,

however, lessens as the plant gets older and is much below the toxic level in the mature plant harvested for bundle feed or silage. Because the HCN content is highest in small plants, sorghum should not be grazed.

Sorghum forage is nutritious and palatable. Oven-dry sorghum forage is usually considered as 52 percent total digestible nutrients, compared with 60 percent in well-eared corn. The protein content of sorghum at the dough to hard seed stage has averaged about 7 percent at Fargo, 1952-57. Varieties vary in protein content depending on leafiness and disease resistance. Sorghum held its forage quality through late summer and early fall periods of drouth or excess rain and wind better than corn at Fargo, and holds a desirable moisture content of 65 to 70 percent for silage better than corn.

SORGHUM

VARIETIES RECOMMENDED

LISTED IN ORDER OF EARLIEST MATURITY

- **RANCHER** A "black amber" type reported to have 1/10 the HCN content of most commercial sorghum varieties. Reaches hard seed stage at Fargo all years. "Low acid" black amber in seed trade is presumably similar to Rancher.
- **FREMONT** Reaches very heavy dough to hard seed at Fargo; 5 to 6 days later than Rancher.
- **RED AMBER** Susceptible to bacterial leafspot. Excelled for yield in early tests at Dickinson, Edgeley and Fargo. Reaches heavy dough to hard seed stage at Fargo.
- **LEOTI RED** Tall, very juicy, sweet stalk, and one of the sweetest forage varieties known. Resistant to bacterial leafspot. Reaches late milk to heavy dough stage at Fargo most years.
- **ELLIS** Very resistant to bacterial leafspot, but later than Leoti Red at Fargo, where it reaches flowering to early milk stage on the average.
- **NORKAN, ROX ORANGE and AXTELL** Very productive but late. Usually reach late boot to early milk stage.

CULTURE OF SORGHUMS

Leoti Red, Rancher and Fremont are now available and recommended in that order for North Dakota on the basis of all varietal characteristics. Rancher is as good as Leoti Red for close drilled seeding. Certified seed should be used. Sorghums probably will perform best in the 85-day or later corn zones.

A clean, compact well prepared **seed-bed** similar to that prepared for corn or grain crops is needed. Sorghum should be sown approximately 2 weeks after corn planting time, or the last week of May to the first week in June, though it can be seeded until July 1 with good pro-

duction if warm moist soil is available.

A **seeding rate** of 5 to 8 pounds per acre in 2 or 3-foot spaced cultivated rows, or 25 to 30 pounds per acre in drilled seedings, is recommended. Four to 6 plants per foot of row is a satisfactory stand. Treat the seed with fungicide. Two-foot cultivated rows have been most productive at Fargo.

One or 2 light inter-row cultivations with sweep-type field equipment has controlled weeds when sorghum is seeded on nitrogen-fertilized grain stubble or summerfallow without nitrogen. Sorghum under favorable conditions has crowded out or suppressed weeds within

RESULTS AT FARGO

3 to 5 weeks after emergence. The seedlings may start slowly, especially in cool soils, so seeding immediately after clean tillage, in a warm soil, is important in weed control. 2, 4-D can be used to control weeds when sorghum is 12 to 15 inches tall.

Seeding depth should be about 1½ inches, using a press drill or suitable row equipment. Row spacings can be adjusted to fit the cultivation equipment available. Seed compartments constructed over appropriate grain drill spouts, or plugging some spouts to give the desired row spacing with a press drill, are usually satisfactory.

Sorghum, like corn, uses nitrogen heavily. Thirty to 75 pounds of nitrogen per acre should be applied on grain stubble, and 30 pounds of nitrogen have given good response on fallow at Fargo. Sorghum uses fertility and moisture late in the season, so nitrogen fertilization of the crop following it is recommended, and fallow may be advisable.

Sorghum is used mainly for silage. The moisture content of Rancher, Fremont and Leoti Red is approximately 68 to 72 percent, ideal for making silage about Sept. 15-20. This moisture content will continue until frost, as the leaves do not dry with seed maturity, as does corn.

Sorghum can be mixed with dry corn to increase the corn moisture content for desirable silage formation. It can also be cut with a binder and cured as bundles in the shock. Allow sorghum to mature until the seed is in the heavy dough stage before ensiling. Sorghum can be ensiled any time from this stage until several days after killing frost, since it holds its leaves and optimum moisture content for several days after freezing.

Stoa¹ reported that 3 sorghum varieties averaged 4.15 tons while Mercer corn produced only 2.73 tons of 15 percent moisture forage an acre at Fargo, 1937-42. Results from 1952-57 below substantiate the 1937-42 report. Forage production at 12 percent moisture (hay) and 70 percent moisture (silage) of 7 sorghum varieties, 2 sudangrass varieties, and 2 corn varieties is presented in Table 1. The experiment was seeded late or about the last week of June in 1952 and 1953 on the basis of shortage of feed and emergency feed crop. Seeding was as near June 1 as soil conditions permitted, 1954-57.

Late seeding dates were used in 1954 and 1955 but forage production was inferior to early seeding date in the same years. Drilled plots and 3-foot spaced cultivated rows were seeded all years and 2-foot spaced cultivated rows, 1954-57.

Forage varieties in 2-foot spaced cultivated rows have produced approximately 1 ton more 12 percent moisture forage than the same varieties in 3-foot rows or drilled plots. Apparently, the plant population is near the optimum for soil moisture and fertility available with a 2-foot row spacing of those spacings tested. The height and other plant characteristics of plants in the 2-foot and 3-foot rows were very similar, or the same size plant was produced in 2/3 the space in 2-foot rows as 3-foot rows. Plants in rows often average 8 feet tall while some varieties averaged 10 feet tall in the warm, moist growing season of 1957 at Fargo. Plants in drilled plots were shorter, less mature, finer-stemmed, and often more disease-

¹Stoa, T. E. Emergency Forage Crops for North Dakota. Bimon. Bul. 2:3-5, 1940 (and unpublished annual reports, 1941-42).

Table 1. FORAGE PRODUCTION AND OTHER CHARACTERISTICS OF SORGHUM IN DRILLED PLOTS AND 2-FOOT OR 3-FOOT CULTIVATED ROWS, FARGO, 1952-57.

Varieties	Tons of forage an acre at 12% moisture, 1952-57 average ^{2/}				Height in inches 1952-57 av.			Seed maturity
	Drilled	2' rows	3' rows	Variety average	Drilled	2' rows	3' rows	
Sorghum								
Fremont	4.86	6.12	4.62	5.20	67	84	78	heavy dough
Ellis	4.44	6.05	4.99	5.16	74	92	92	early milk
Rancher	5.58	5.97	4.96	5.50	75	86	85	hard seed
Leoti Red	4.95	6.21	4.97	5.38	69	92	87	milk to dough
Norkan	4.89	7.06	5.05	5.67	58	87	82	late milk
Rox Orange	5.27	5.78	5.08	5.38	63	86	85	late milk
Nebraska Red Amber	5.66	6.26	5.36	5.76	81	97	94	dough
Sudangrass								
Piper	4.62	5.08	4.26	4.65	77	92	90	hard seed
Sweet	4.27	4.65	4.40	4.44	72	82	78	heavy dough
Corn								
Mandan Flint ^{1/}		4.51	3.81	4.16		70	71	glazed
Nodak 301		5.02	3.93	4.97		78	79	early dent
All sorghum average	5.09	6.21	5.00	5.44	70	89	86	

^{1/}Mandan flint and Nodak 301 whole plant yields from earlier seedings, checked corn, in the corn project of Mr. Wiidakas, were 4.12 and 4.09 tons of 12 percent moisture forage an acre for the 1952-57 period.

^{2/}Multiply tons at 12 percent moisture by 2.9 to give silage yields at 70 percent moisture, or Leoti Red produced 6.21 tons x 2.9=18.0 tons of 70 percent moisture silage an acre in 2-foot rows at Fargo, 1952-57.

damaged than those in cultivated rows.

Rancher excelled for forage production in drilled plots of the varieties tested all years. All varieties produced similar amounts of forage in the 3-foot cultivated rows, although Fremont was slightly less productive. Norkan produced significantly more forage than the other varieties in 2-foot cultivated rows. Considering all varietal characteristics, Leoti Red is recommended for sorghum production in rows. Rancher and Leoti Red are recommended in drilled plots—Rancher is more productive but less palatable and much more susceptible to damage and leaf drop from bacterial leaf-spot.

Forage sorghums produced approximately 1 ton more forage than Piper and Sweet sudangrass in drilled plots. One or more forage sorghum varieties have produced more forage than corn each

year and for all years in these experiments.

These sorghum yields also excel those obtained from earlier seeded corn in the regular corn project. See Table 1. (Nodak 301 and Mandan flint have produced 4.09 and 4.12 tons at 12 percent moisture and 12.0 and 12.1 at 70 percent moisture, respectively, 1952-57, at Fargo in the corn project).

The drilled sorghum yield of 5.09 tons an acre is about the same as Nodak 301 and greater than Mandan flint in 2-foot cultivated rows and is considerably greater than these corn varieties in 3-foot rows. The average forage production of all forage sorghum varieties is significantly greater than corn for both 2-foot and 3-foot spaced cultivated rows. Several forage sorghum varieties out-yield corn by as much as 1½ tons of forage.



Fig. 2. Drilled sorghums averaged 19 tons of silage an acre to 11 tons from Piper sudan in 1953, Fargo.

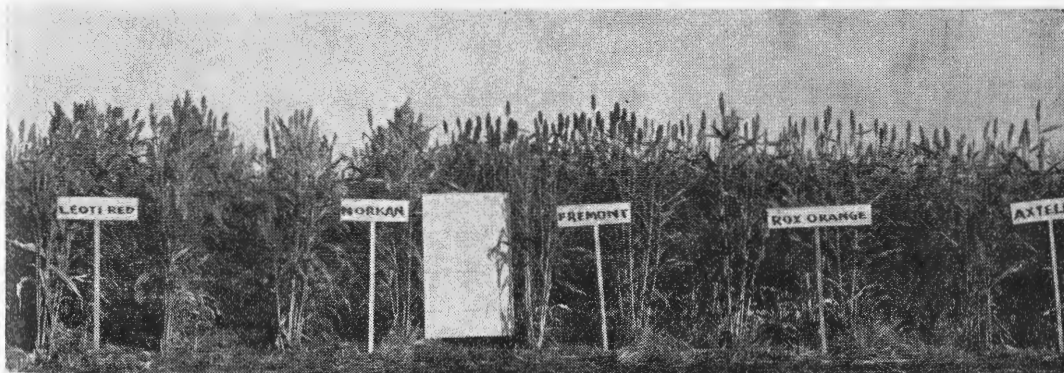


Fig. 3. Sorghums in 3-foot cultivated rows averaged 15 tons of silage to 9½ tons from corn an acre in late May seeding, 1953, Fargo.

Table 2. TONS OF FORAGE PRODUCED BY FORAGE SORGHUM, SUDANGRASS, AND CORN GROWN AT BRANCH AGRICULTURAL EXPERIMENT STATIONS 1954-57.

Varieties	(2) Edgeley 1954-57		(3) Langdon 1954-55		(4) Minot 1954-56		(5) Williston		1954-56		(6) Dickinson 1954, 1956 1957
	Rows	Drilled	Rows	Drilled	Rows	Drilled	Irrigated	Rows	Drilled	Dry Land	Rows
Sorghum											
Fremont	2.84	3.80	1.75	1.66	1.58	2.04	5.17	5.14	1.56	1.64	1.55
Norkan	3.30	3.00	1.57	1.43	1.13	1.62	5.08	4.85	1.27	1.35	1.41
Rox Orange	3.08	2.62	1.30	1.24	1.23	1.62	5.39	4.54	1.27	1.35	2.00
Leoti Red	3.16	3.24	1.27	1.31	1.32	1.84	5.42	4.95	1.30	1.57	1.78
Rancher	2.75	3.30	1.67	1.65	1.64	2.67	5.30	5.31	1.44	1.77	1.55
Red Amber	2.85	4.38	1.47	.83	5.66	4.56	1.55
Piper sudangrass	2.04	2.72	1.30	1.66	1.51	2.04	4.28	4.38	1.00	1.48	1.22
Sweet sudangrass	2.06	2.73	.98	1.11	1.18	1.90	4.02	4.10	.96	1.21	1.15
Corn											
Mandan flint corn	2.72		1.67		1.32		4.63		1.37	
Nodak 301 corn	2.93		1.20		1.05		4.23		1.52	
Mandan flint corn ^{1/}	3.30		2.25		2.43		5.16		2.43		2.26
Nodak 301 corn ^{1/}	3.08		1.58		2.43		4.00		1.97		2.02
All sorghums av.	3.00	3.40	1.51	1.36	1.38	1.96	5.35	4.90	1.37	1.54	1.64

^{1/}Corn seeded early (May 15-25) in regular corn silage trials including several other corn varieties at branch station; Mandan flint corn, also known as Rainbow Flint, Mandan strain.

^{2/}Seeded in early June, harvested Sept. 15-Oct. 1 each year; all yields at 12 percent moisture except early planted corn reported as "field dry" weight, that is, 4-8 weeks in field after harvest.

^{3/}Seeded in early July; yields in tons at 12 percent moisture.

^{4/}Seeded about June 15; yields in tons at 15 percent moisture; drilled sorghum usually does not head out at Minot although sudan does.

^{5/}Seeded about June 15; irrigated plots received 50 pounds of nitrogen fertilizer an acre; yield in tons at 12 percent moisture. Dryland rainfall below normal in 2 of 3 years.

^{6/}Forage yields at 12 percent moisture; 1955 data omitted as sorghum failed from weed invasion; no drilled data available.

BRANCH STATION RESULTS¹

Forage sorghum versus corn and sudangrass forage production at the branch experiment stations is shown in Table 2. These tests are continuing at the Edgeley and Dickinson stations. Sorghum has been as productive as late planted corn at Langdon, Minot and dryland Williston; less productive at Dickinson and more productive at Edgeley and irrigated Williston.

Earlier seeded corn in "silage trials" has been more productive than late seeded sorghums, except at Edgeley and irrigated Williston.

Drilled sorghums have excelled cultivated rows at Edgeley, Minot and dry-

land Williston. Five forage sorghums produced more forage but slightly less total digestible nutrients per acre than corn at Dickinson, 1939-42.² Drilled sorghum saves the labor and machinery for cultivation but requires more seed for seeding and machinery for chopping a drilled solid stand of plants 3 to 6 feet high. The earliest maturing varieties, Rancher and Fremont, have produced better than the later varieties at the northern and western stations.

^{1/}Miles White, Edgeley; Victor Sturlaugson, Langdon; Gus Geiszler, Minot; Howard Olson, Williston and Tom Conlon, Dickinson, provided the data presented in Table 2.

^{2/}Unpublished annual reports, 1939-44, of R. W. Smith.