4-1954

Progress in Agricultural Research at the North Central Substation

B. Brage
South Dakota State University

F. C. Westin
South Dakota State University

G J. Buntley

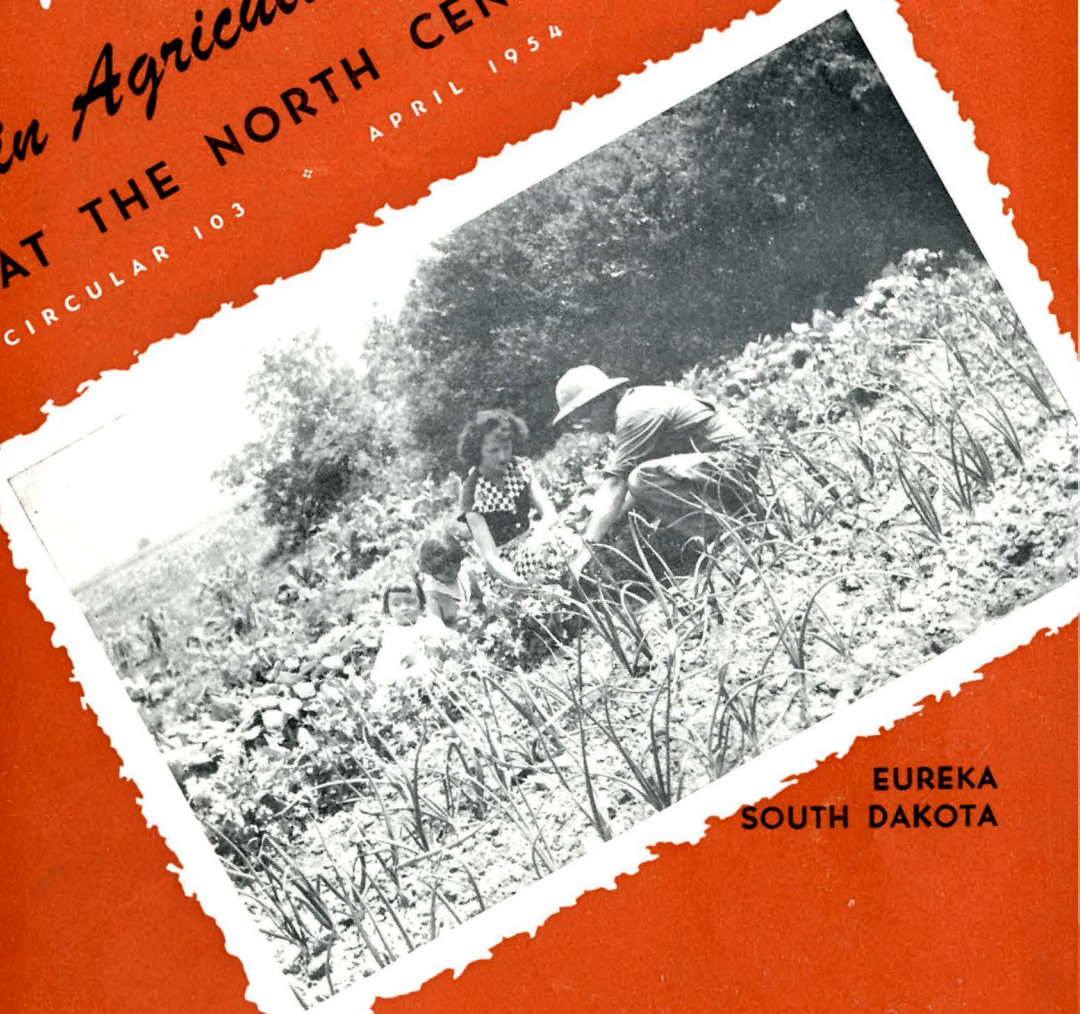
V. A. Dirks

Progress in Agricultural Research

AT THE NORTH CENTRAL SUBSTATION

File Copy

CIRCULAR 103 * APRIL 1954



EUREKA
SOUTH DAKOTA

AGRICULTURAL
EXPERIMENT STATION
SOUTH DAKOTA STATE COLLEGE
BROOKINGS, SOUTH DAKOTA

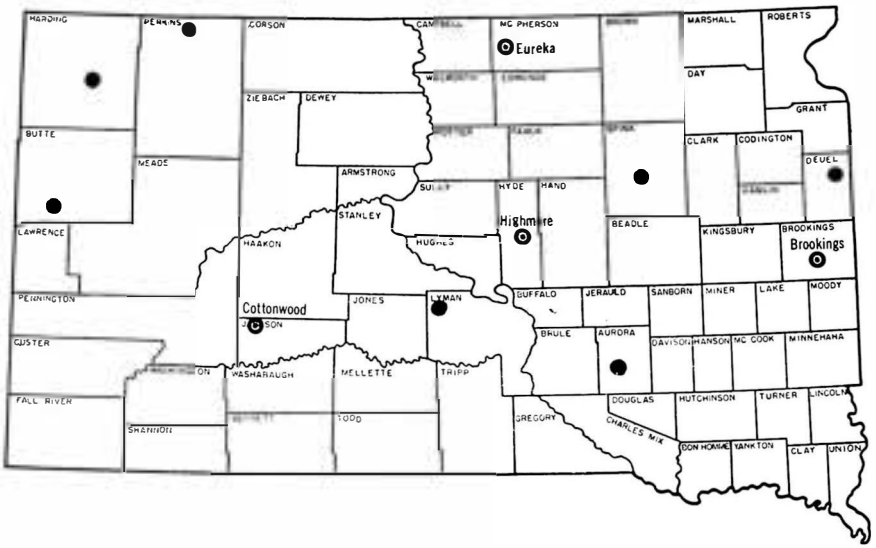


Fig. 1. Location of the three main substations of the Agricultural Experiment Station. Experimental work is being carried on at the other locations marked on the map.

Table of Contents

North Central Substation

North Central Substation

Introduction

THOUSANDS OF ACRES of farm land in the north central part of South Dakota have their productive future tied up with the 240 acres used for experimental research at the Substation at Eureka.

Established nearly 50 years ago by the state legislature, which set aside state school lands for agricultural research, the North Central Substation is the proving ground for new agricultural methods and a living record of the accumulative effects of the old.

As early as 1908, rotation experiments were started which became the first historical record in the northern plains area of the effects of cropping practices on the soil.

At that time, the entire surrounding country was in wheat. There were no crop rotations, since the organic matter of the soil was good and the fertility level high. Also, there was no weed problem then.

Later, the Experiment Station was to be accused of "scattering weeds" in one of the most interesting stories to be uncovered in the development of experimental research in this area. Foreseeing the time when the fertility of the land might become dangerously lowered by the practice of continuous cropping which was being carried on at that time, the Substation set up experimental plots. These included the basic crops of rotation—cultivated crops, small grains and legumes. In this case, the legume was sweet clover.

In a few years time, the wind and the birds scattered the clover seed over the surrounding countryside, and soon, farmers had sweet clover growing in their wheat fields. This "plant out of place" was their "weed." An editor of a newspaper in another farming area, not understanding the purpose of the experiments, published a story saying that if the Experiment Station scientists had nothing better to do than scatter weeds around the country, they might as well be fired.

Fortunately, more foresighted individuals did not share his opinion. The Substation improved its rotations and corn lines, and showed by example that crops other than wheat could be raised in that area. They proved that by having wheat follow

corn in the rotation, sweet clover could be used as a legume. Cultivation of the corn kept the land clean of weeds and there was no longer a problem of sweet clover "weeds" in wheat fields.

At the time the Substation was established, hybrid corn was not known. Corn used in the rotations was developed particularly for that area by crossing alternate lines of two kinds of corn grown in adjoining rows. An early maturing, good yielding, yellow variety of corn, which came to be known as "Eureka" enjoyed a great deal of success until the event of hybrid corn. Since then, through plant breeding, several good varieties of early corn hybrids have been developed for the northern part of South Dakota.

In the early days, people in this part of the state thought of corn as something to be grown in garden plots. No one thought corn could be grown on a large scale in this northern area. One of the first farmers to introduce corn growing into the area was Joe Stephen, an early corn enthusiast. Now, although corn is not a major crop in this area, about 500,000 acres are planted to this crop each year.

In the beginning, an attempt was also made to establish a plum orchard, but a bad hail storm wrecked the trees and the orchard was abandoned. In 1941, the orchard was again established with a variety of fruits developed by the Station, to see if fruit for home use could be grown in the north central area of the state. These consisted mostly of plum-sandcherries, apricots, apples and crabapples. In the last few years, other quality fruit has also been added.

In later years, the research was no longer confined to crops when a demand arose for information on livestock and poultry. Projects were set up on establishing alfalfa in range pastures, in studying the best time to cut prairie hay, and in breeding swine and poultry.

A flock of registered Hampshire sheep was maintained at the Substation during the early 40's. Owing to the limited acreage for pasture and to the fact that the farmers had asked for research on beef cattle and hog production, the flock was discontinued after six years. The results obtained with sheep at the Substation indicate possibilities for sheep production in the area.

The buildings, which were planned by H. C. Solberg, mechanical engineer at South Dakota State College, were constructed with money appropriated by the legislature. Now there is a 6-room house, barn, cattle shed, machine shed, seed house, all of frame construction, and a poultry house built of rammed earth. The house, barn and seed house were constructed in 1908 and '09, and many improvements have been added since then.

But the real value of the 240 acres that make up the North Central Substation lies in the knowledge of agricultural practices gained through research, the new varieties developed and tested, and the pioneering which has been accomplished in the realm of agriculture.

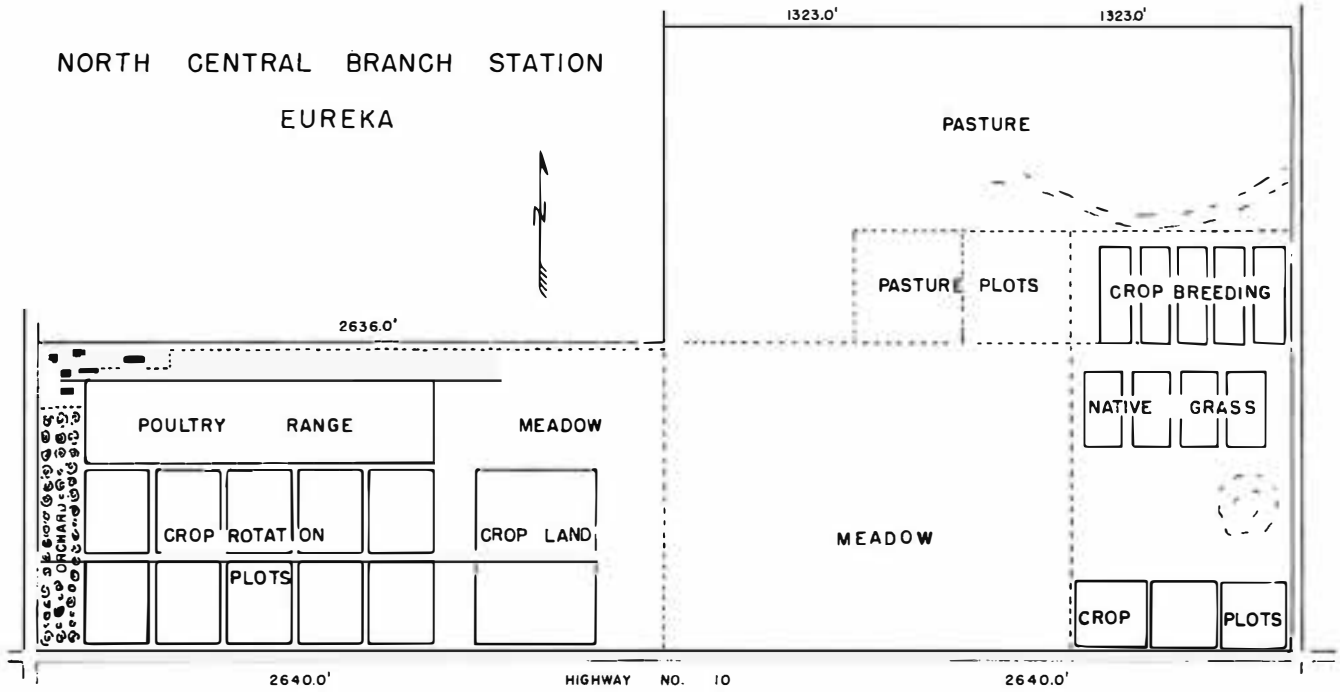


Fig. 2. Diagram of the farm and the experimental plots at the Substation

Soil and Weather

Soil and Weather

THE LANDSCAPE of the area around the North Central Substation at Eureka is rolling, with strong irregular slopes and sharp changes in local relief. Many unconnected depressions or pot holes of all sizes dot the landscape. No defined stream courses exist and excess precipition is drained off to the nearest depression.

The climate is dry (subhumid to semi-arid) with an annual rainfall of about 16 inches. There are extremes of summer heat and winter cold, and rapid changes of temperature. About three-fourths of the annual precipitation comes between April and September, and normally, June is the wettest month. Although the average rainfall of 16 inches is sufficient for successful farming and ranching, the average cannot be depended on. The risk of drought is always present.

The native vegetation consists mostly of short grasses on rolling loamy soils. On the wet areas and on sandy soils, the mid and tall grasses become dominant.

The parent materials of the soils of the north central area are glacial till of clay loam texture, consisting of a mixture of ground up granite, limestone, shale and sandstone rocks.

Soils Have Three Dimensions

Besides depth, which is the soil profile, soils have breadth and width dimensions. Soils are landscapes as well as profiles.

The landscape of the North Central Substation is typical of the rolling area of this region of South Dakota. It consists here of a succession of rounded hills having many short, steep slopes which are separated in part by low lying swales and in part by swampy depressions. The soil profiles of the upland area are developed in glacial till, those in the swales are developed in a layer of material washed down from the higher areas, and those in the wet depressions are developed almost entirely in washed material to which the organic remains of plants have been added.

The soil profiles of the North Central Substation can be conveniently classed into two groups: the upland soils and the swampy depressional soils. As the latter have limited agricultural possibilities, they need not be considered here. The upland soils, which include the soils in the swales, vary somewhat in depth to parent material. On the short steep slopes much of the soil has been eroded, while in the swales the profiles have actually been thickened

by additions of washed material.

The typical soil profile occupies the less steep areas not in swales. These typical or modal soils are well drained. Their profiles are moderately permeable to roots, air and moisture, and have good water holding capacity. Stones may occur in or on the soil. A profile description follows:

A_1 0-4" Very dark gray, friable silt loam of weak prismatic structure.

B_2 4-18" Dark yellowish - brown, friable, silty clay loam, of moderate prismatic structure.

C_{ca} 18-30" Light olive brown clay loam glacial till, friable, strongly calcareous, moderately saline.

These typical soils are quite fertil and have good tilth where not eroded. They are not subject to wind erosion except during prolonged drought. They are moderately productive in years of good rainfall.

In the north central area, these typical soils are used for both cropland and pasture. In order of importance the principal crops grown are: spring wheat, wild hay, barley, oats and corn. Pasture makes up 30 to 40 percent of the land in farms.

The soils map on page 13 shows the distribution of the soil described above on the various slopes, and also the location and size of the swampy depressional areas.

Soil and Weather

Soil Fertility

SOIL FERTILITY problems are rapidly becoming paramount in importance in crop production. For a number of years, it was thought by many people in South Dakota that the lack of rainfall was the only limiting factor in crop production. Rainfall definitely is an important factor, but recent research has shown that soil fertility is also an important factor. Fortunately the soil fertility level can be controlled, whereas the control of rainfall in a given area is questionable. Crops growing on a soil in a good state of fertility will make more economical use of the moisture that does fall, than crops growing on soils in a poor state of fertility.

Soil investigations were initiated at the North Central Substation at Eureka in 1912 to evaluate some of the more pertinent soil fertility problems at that time. These early investigations, for the most part, were discontinued in 1936 for lack of funds. Much of the information from this early experiment is published in Bulletin 325, "Thirty Years of Soil Fertility Investigations in South Dakota." The soil fertility experiments to be discussed in this publication will be concerned with the research done since 1942.

The fertility experiments started in 1942 consisted of three different rotations: (1) corn–oats, (2) sorghum–oats, and (3) corn–oats–sweet clover–sorghum–oats–sweet clover. In the latter rotation, the sweet clover is planted in the oats and clipped the following year in June, then plowed under in late summer. The plots are one acre in size, and the rotations are repeated twice.

Yield averages of the different crops for the 12-year period are used. Three comparisons that can be obtained from the yield data are as follows: (1) the effect of corn compared to the effect of sorghum on the yield of the crops that follow, (2) the influence of sweet clover versus no sweet clover in a rotation on the yield of other crops in that rotation, (3) the effect of drilling versus checking of corn on the yield of corn as well as the yield of the crop that follows.

Grain Yields Following Sorghum or Corn

Is the yield of grain following sorghum as high as the yield of grain following corn? This is a very common question in South Dakota. Table 1 reveals that the yield of oats following corn did not have a consistent advantage over that following sorghum. In the 2-year rotation where no legume was used, the yield of oats following corn was 2.5 bushels greater than the yield of oats following sorghum. In the 6-year rotation where sweet clover was included, the yield of oats was 2.6 bushels greater after sorghum than after corn. These differences in yield are of little consequence because of their small and variable nature. If the weeds were controlled in sorghum as well as they were in corn, the yield of the grain following either row crop was very similar.

Table 1. Average Yield of Oats Following Corn or Sorghum, 1942-53

Crop Sequence	Oats Non-Legume Rotation	Oats Legume Rotation
	Bu./A.	Bu./A.
Corn-oats	48.3	66.3
Sorghum-oats	45.8	68.9

Effect of Legumes in Crop Rotations

The remarkable effect of legumes in a rotation on the yield of oats is shown in Table 1. When a legume was included in the rotation, the yield of oats following corn was 18 bushels more than when no legume was included. The yield of oats following sorghum in the legume rotation was 23.1 bushels more than the yield of oats from a non-legume rotation.

To overcome the disadvantage of losing two crops out of six, which is normally the case in the legume rotation, a sweet clover seed crop may be harvested in some years. The harvesting of a sweet clover seed crop would not materially reduce the yield of the following crop or reduce the soil fertility to any appreciable extent. The increase in yield of crops following legumes, together with the harvesting of a sweet clover seed crop in some years, would make the legume rotation more desirable.

Table 2. Effect of Sweet Clover in a Rotation on the Average Yield of Corn 1942-53

Treatment	Corn Bu./A.
Legume	27.6
No legume	26.3

Corn yields have not been increased very much by including a legume in the rotation (Table 2).

The yields of corn are not exceptionally high, because the North Central Substation is out of the Corn Belt proper. For this reason the yields of corn are not greatly influenced by improved soil fertility. The effect of legumes on corn yield, to date, as shown by the data, is too small to be of any consequence.

Nitrogen is usually the most needed element for corn in South Dakota. However, in the western and extreme northern part of the state, corn does not generally respond as much to nitrogen as does corn in the southeastern part of the state. In the northwestern area of the state, corn gets a late start, and by the time the crop advances to the stage where it requires a high amount of nitrogen, ample nitrogen in an available form is generally released by natural means in the soil. The crops that followed corn were benefited, however, if sweet clover preceded the corn crop.

Corn Planting Methods

Since 1949, methods of planting corn have been studied in both the 2-year and 6-year rotations. The yields of corn and the yields of oats following corn are presented in Table 3.

Where a legume is included in the rotation, drilled corn yielded 3.5 bushels over the checked corn. In the non-legume rotation, drilled corn yielded 2 bushels more than checked corn. The yield of drilled corn was greater than that for checked corn, but the yield of oats following drilled corn was less than the yield of oats following corn where the checking method was used. This relationship was true for both the legume and non-legume rotations. It appears from these data that the method of planting corn should depend to a large extent on the farmer's preference, as the final outcome in total yield of crops in a rotation would be about the same.

Table 3. Effect of the Method of Planting Corn on the Yield of Corn and the Following Oats Crop, 1949-53

	Yield of Corn		Yields of Oats	
	Non-legume Rotation	Legume Rotation	Non-legume Rotation	Legume Rotation
	Bu./A.	Bu./A.	Bu./A.	Bu./A.
Corn drilled	34.7	38.3	32.0	60.5
Corn checked	32.7	34.8	36.9	66.3

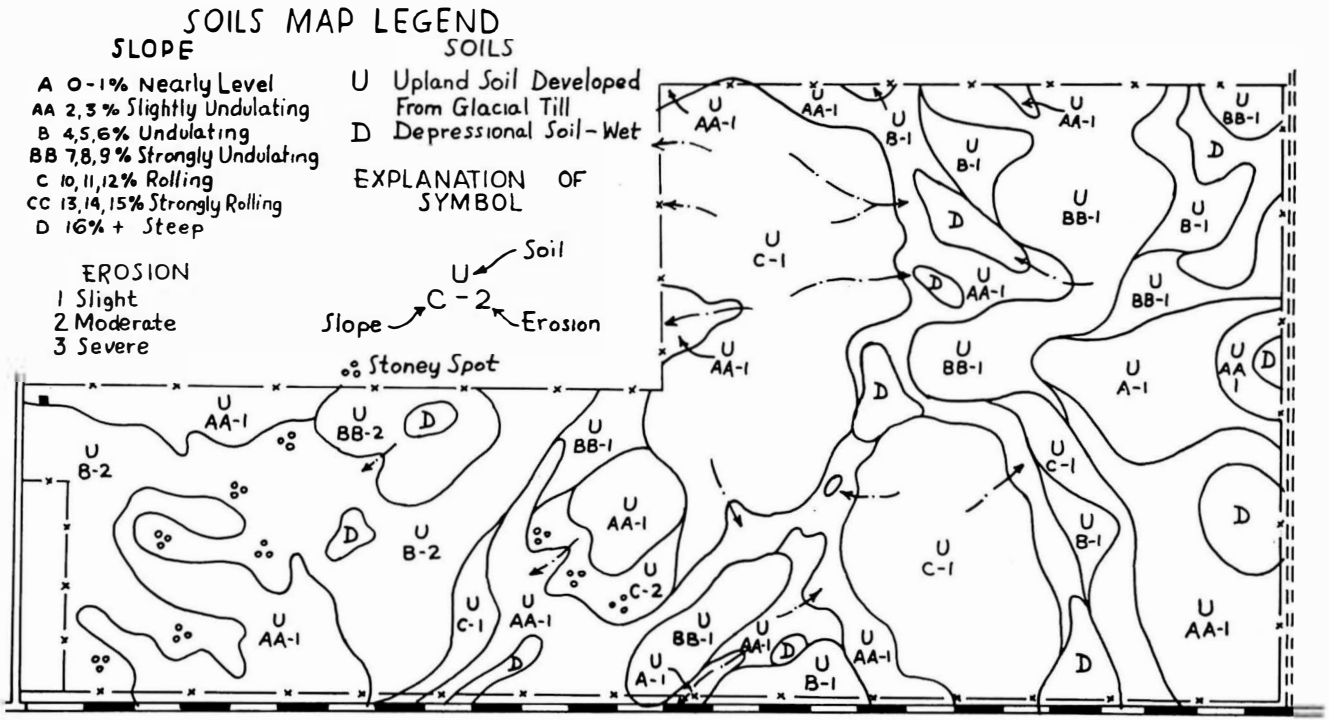


Fig. 3. Soils map of the North Central Substation at Eureka

Small Grains

Small Grain Yield Tests

SMALL GRAIN yield trials have been conducted at the North Central Substation without interruption since 1942. During this 12-year period there were no total crop failures, although yields were very low in some years. In 1950, the plots were moved to a new area on the Station. Thus, the 4-year period, 1950-53, reflects a higher level of soil fertility and condition than the preceding eight years.

In the varietal yield tables for each crop, averages for the periods 1942-49 and 1950-53 are given, as well as the average performance over the entire 12-year period, where possible. Besides these averages, the 1953 yields and test weights are given separately. Useful information on varietal reaction to such factors as stem rust, leaf rust, lodging and drought, are included, with the year the observations were made.

Some of the small grain varieties developed at the South Dakota Experiment Station have been outstanding and have contributed markedly to the agricultural economy and stability of the entire north central area. Examples of this are Rushmore spring wheat, Odessa malting barley, Feebar feed barley, Vikota and James oats, and Pierre rye.

Table 4. Spring Wheat Yield Tests at Eureka, 1942-53

Variety	Yield in Bushels per Acre 1942-53 Av.	1942-49 Av.	1950-53 Av.	1953	1953 Test Wt. Lbs./Bu.	1953 % Stem Rust	1953 Scab Rating*	1950 % Leaf Rust
Bread Wheats								
Lee	—	—	20.7	18.6	56.0	20	4	2
Rushmore	19.7	19.8	19.7	16.1	54.0	15	4	30
Thatcher	18.1	17.5	19.2	14.8	49.5	30	5	50
Mida	21.3	22.1	19.7	14.7	54.0	30	6	30
Ceres	18.7	19.4	17.4	12.4	51.0	25	4	40
Rival	20.0	21.4	17.1	9.7	49.0	40	4	30
Pilot	19.5	20.2	18.1	13.0	51.0	15	4	35
Cadet	19.4	19.2	19.8	15.5	51.0	25	5	30
T x Tri 630	—	—	—	25.2	61.0	8	2	5
R^2xS PW36	—	—	—	21.6	59.5	8	2	0
Selkirk	—	—	—	30.4	57.2	10	5	0
Durum Wheats								
Mindum	17.4	18.0	17.0	5.8	45.0	40	7	0
Stewart	17.0	17.0	16.2	3.9	39.5	50	6	0
Vernum	17.1	17.8	16.0	4.8	42.5	50	8	0
Nugget	—	—	16.5	3.7	36.2	70	8	0
Sentry	—	—	—	14.3	53.0	70	7	0
Least significant difference	1.7	2.3	2.1	3.6				

*Rating score: 1 = least severe; 10 = most severe.

Spring Wheat Yield Tests

SPRING WHEAT is the predominant cash crop in north central South Dakota. The preformance of spring wheat, both bread and durum types, is indicated in Table 4. At Eureka the Mida plant type seems unusually well adapted which is evidenced by the performance of Mida over the 12-year period, and especially prior to 1950. Beginning in 1950, the appearance of race 15B of stem rust, to which Mida is more susceptible than the two bread wheat varieties Rushmore and Lee, has resulted in Mida having lower yields. This is especially evident in the 1953 yields. Mida was also hurt by scab in 1953.

The durum wheats, which formerly yielded on a par with the bread wheats, are so susceptible to 15B that the present varieties are no longer in the picture. New varieties of both bread and durum wheat are coming, and the 1953 yields gave an estimate of the potential value of some of these, like Selkirk. Until these become available, however, the grower can gain some protection by growing the varieties Rushmore and Lee rather than Mida or the durum wheats.

Small grain rod row plots showing different response to heat

Small Grains

Barley Yield Tests

THE NORTH CENTRAL area of South Dakota is well suited to the production of barley as a source of livestock feed concentrates. The feed type barleys have given excellent yields in the 12-year period and the recent production of new varieties such as Velvon 11 and Tregal has served to increase the stablilty of feed barley production. Odessa has been the superior malting barley at Eureka. In 1953, heavy infection of stem rust and scab occurred. Disease notes, yields under these conditions, and long-term average yields are given in Table 5.

Table 5. Barley Yield Tests at Eureka, 1942-53

	Yield in Bushels per Acre				1953	1953	1953	1953	1953
	1941-53 Av.	1942-49 Av.	1950-53 Av.	1953	Test Wt. Lbs./Bu.	% Stem Rust	Scab Rating*	Bact. Stripe*	% Shattering
Malting types									
Odessa	34.9	31.5	41.7	42.9	48.0	2	3	3	Tr.
Barbless	33.3	32.5	34.9	32.7	47.0	5	4	4	30
Kindred	----	----	31.2	31.2	48.5	0	7	4	30
Montcalm	----	----	38.3	39.3	48.5	20	5	3	20
Feed types									
Plains	33.2	32.3	34.8	36.9	49.0	0	3	6	0
Feebar	37.4	36.7	38.6	32.8	44.0	0	1	2	0
Spartan	27.9	25.5	32.8	27.9	50.0	10	1	4	0
Trebi	39.7	36.5	46.0	39.6	47.0	10	3	3	0
Velvon 11	----	----	46.6	45.9	45.0	30	3	5	0
Tregal	----	----	41.9	40.4	44.5	8	3	3	0
Mars	----	----	28.5	23.4	48.0	0	6	5	5
Least significant difference	2.4	2.9	4.2						

*Rating score: 1 = least severe; 10 = most severe.

Small Grains

Oat Yield Tests

THE LONG-TIME performance of oat varieties at the North Central Substation definitely favors early oat varieties of the Richland type, as well as Marion. This situation is still substantially the same through 1953, although considerable changes have occurred in disease patterns. Oat diseases appear less of a hazard in north central South Da-

kota than in some other areas of the state. Drought resistance, heat tolerance, standability and adaptation to the climate appear to be very important in determining the performance of oat varieties. The heavy-strawed type of oats has not done well in the north central area of South Dakota, even when diseases and moisture shortage were not apparent.

The results of the oat tests have been remarkably consistent over the years. The highest yielding and most dependable oat varieties have been Vikota, Osage, Dupree, and Marion.

Table 6. Oat Variety Tests at Eureka, 1942-53

Variety	Yield in Bushels per Acre				1953 Test Wt. Lbs./Bu.	1953 % Stem Rust	1953 % Lodging	1953 Height Inches
	1942-53 Av.	1942-50 Av.	1950-53 Av.	1953				
Brunker	43.9	37.8	54.5	59.4	33.8	20	100	34
Trojan	43.9	36.3	57.5	55.8	33.2	40	60	34
Andrew	—	—	63.0	74.6	38.6	10	0	35
Mindo	—	—	60.1	53.1	35.8	20	40	33
Osage	—	—	67.4	72.5	37.8	1	0	29
Cherokee	—	—	61.3	69.8	36.6	20	0	35
Nemaha	—	—	60.8	62.6	37.6	20	15	32
Vikota	53.4	46.4	67.3	71.0	36.6	1	0	30
Tama	—	50.7	—	—	—	—	—	—
Richland	55.3	48.8	68.1	66.2	36.4	1	0	28
Clinton	53.6	49.1	62.5	54.4	35.4	30	0	34
Marion	—	—	68.4	72.7	37.9	5	0	36
Bonda	—	—	—	55.0	37.0	30	0	37
James	—	—	74.5	51.9	45.2	30	20	34
Shelby	—	—	—	43.8	30.8	40	50	34
Clintafe	—	—	—	46.9	30.8	30	0	37
Ajax	—	—	71.0	73.8	34.9	5	0	38
Dupree	—	—	67.7	78.6	37.5	20	30	31
Mo. 0-205	—	—	—	62.3	39.4	4	40	34
Waubay	—	—	—	67.2	40.6	4	0	38
Least significant difference	2.9	3.6	5.1	11.1				

Small Grains

Rye Yield Tests

RYE IS the only fall-sown grain that will survive the winters in the north central area. Rye data are less complete than those on other crops. Yields at the Substation appear to be primarily a matter of winter survival. Of the present varieties, Pierre has the most winter hardiness, and the highest yields. Other rye varieties are in a lower yield class.

Table 7. Rye Yield Tests at Eureka, 1949-53

Variety	Yield in Bushels per Acre		Test Wt., Lbs.	Average Survival %
	1949-53 Av.	1953	1953	1949-53
Pierre	23.6	46.3	56	88.8
Dakold	18.5	38.4	56	85.2
Emerald	19.3	41.2	55	78.8
White Soviet	19.3	39.8	55	79.2
Tetra Petkus	—	21.3	50	—
Least significant difference	1.7	4.8		

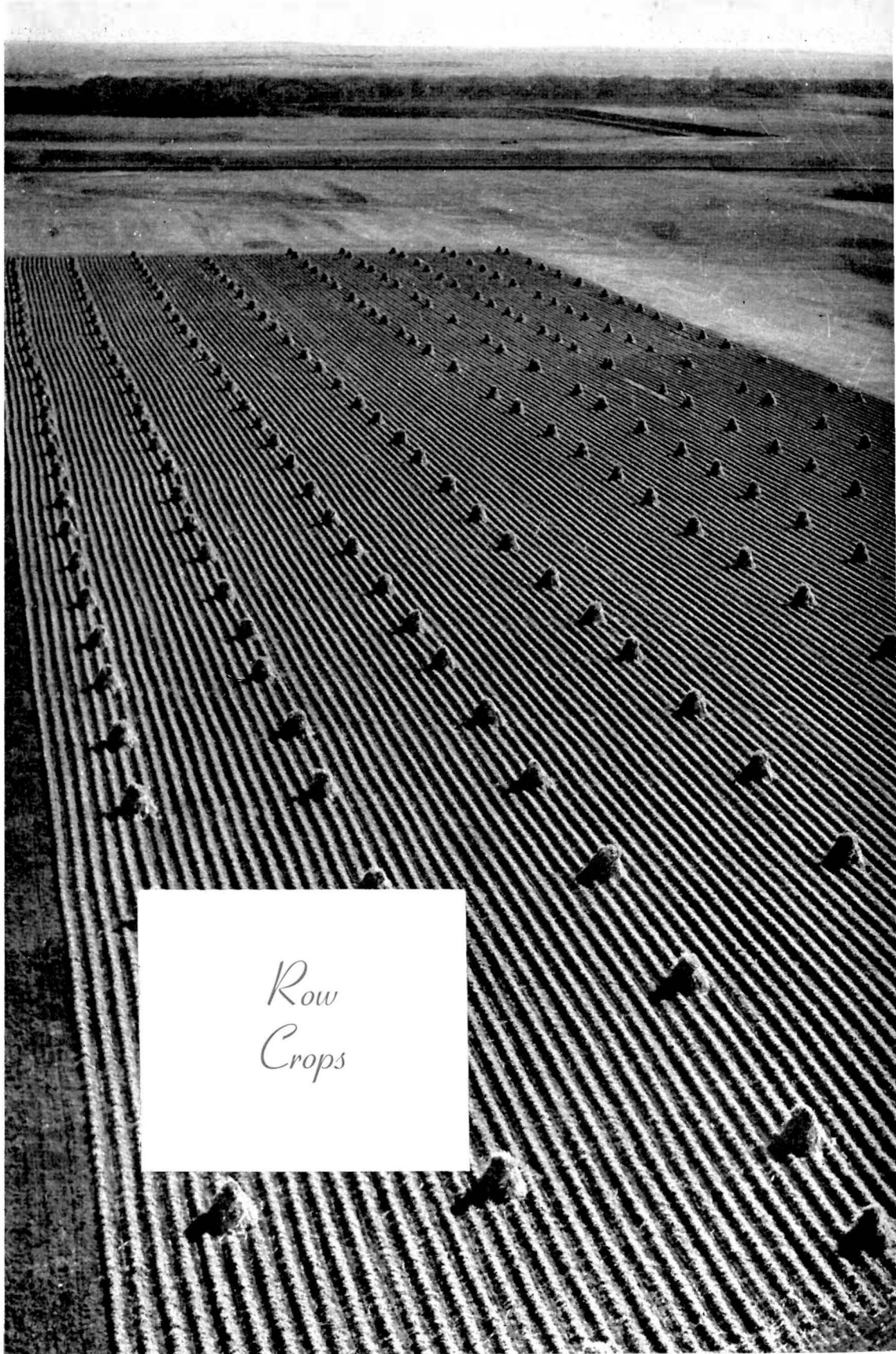
Small Grains

Flax Yield Tests

FLAX YIELD TESTS at Eureka have been run continuously since 1948. Table 8 gives the 6- and 3-year averages for some of the varieties available. Variability on these tests has been high, and differences among varieties in most years are not significant. The averages indicate that growing early varieties involves no loss in yield, and reduces the risk of heat, hail, drought, insects and disease. The 1948-50 averages reflect varietal performance under dry conditions, 1951-53 under more favorable conditions. The absence of flax rust at the North Central Substation in these years has resulted in a very satisfactory performance of the rust susceptible varieties, Koto and Dakota. Since Marine and Sheyenne have rust resistance and earliness, they are recommended for this area.

Table 8. Flax Yield Tests at Eureka, 1948-53

	Yield in Bushels per Acre				1953
	'48-'53 Av.	'48-50 Av.	'51-'53 Av.	1953	Test Wt. Lbs./Bu.
Redwing	12.4	9.6	15.2	9.1	56
Sheyenne	13.4	12.2	14.7	12.0	55
Marine	—	—	15.0	11.6	55
Koto	14.9	12.0	17.8	13.6	56
Dakota	14.8	12.5	17.0	13.6	56
Arrow	12.4	10.2	—	—	—
Bison	11.5	11.2	—	—	—
Redwood	15.5	—	17.1	13.6	56
Differences not significant					


Row
Crops

Row Crops

Corn Yield Trials

WHILE CORN is not a major crop in the agricultural area represented by the North Central Substation, still about 500,000 acres are planted to this crop each year and an average of from seven to nine million bushels are harvested annually. Because the region is located in the northern part of South Dakota and, in general, has a rather high elevation, very early hybrids are needed to assure the harvesting of mature corn. To help farmers select such varieties, yield tests are conducted each year on the earliest commercial hybrids now sold in the state and on early maturing material being developed by the South Dakota Agricultural Experiment Station. In 1953, for example, one trial on single crosses and three on experimental double crosses were conducted in addition to the work on commercial hybrids.

Yield and Maturity Determined

Information obtained on each entry tested has included yield in bushels per acre and the percentage of moisture in the ears at the time of harvest. Moisture percentage is directly related to maturity, the driest hybrids being the earliest ones. A comparison of the moisture percentages of new varieties with that of older, well known hybrids gives an indication of their relative maturities.

Only Widely Used Commercial Hybrids Tested

Many different corn hybrids are advertised and sold in the north central area each year. It is impossible to test them all, and only those most widely used are included. These are determined by having the county agents survey each county as to the hybrids being grown to the greatest extent and by obtaining information from the corn companies as to which hybrid numbers are in the greatest demand.

30- to 40- Bushel Yields Are Possible

From 20 to 25 commercial hybrids have been tested each year. Results obtained covering the 5-year period, 1949-1953, show that an average yield of 32.2 bushels per acre was produced for all entries (Table 9). The hybrid with the highest 5-year average yield, Wisconsin 240, produced 36.3 bushels per acre. On the basis of several years' results, Wisconsin 240, Sokota 220, Pioneer 388, Nodakhybrid 304, DeKalb 46, Kingscrost KE2, and Sokota 212 pro-

duced the most corn per acre. The open-pollinated variety, Hansmann, ranked with the top hybrids in grain production. However, Hansmann has flint type stalks with low ears and considerable lodging.

In 1953 an average yield of 46.1 bushels of grain per acre was produced, and the top yielding hybrid, Pioneer 388, produced 52.2 bushels. All entries averaged 16.9 percent moisture at the time of harvest, with the wettest entry having 22 percent moisture. Thus, sound corn was produced by all hybrids and varieties.

Many Hybrids Too Late for Northern South Dakota

The 5-year average moisture percent at the time of harvest was 34.2 percent. The 2-, 3-, and 4-year averages were 18.2, 33.0, and 35.5 percent, respectively. This shows that quite often hybrids now being used in the area do not mature and that care should be used in selecting early varieties. Of the better yielding hybrids mentioned above, Wisconsin 240 and Kingscrost KE3 are the earliest (have the least moisture percentage). Sokota 220 may be regarded as a full-season corn for the area and hybrids or varieties having more moisture should be considered as late.

Breeding Material Looks Promising

Several single crosses of inbred lines have been tested for a 3-year period (Table 10). In comparison with the check hybrid, Sokota 220, many of the entries not only yielded more but were earlier. By using a method of prediction involving the single-cross results shown in Table 10, several new double-cross hybrids with better performance than the check should be possible. For example, the double cross, (2 x 6) x (5 x 4) has a 3-year average predicted yield of 38.4 bushels per acre as compared with 35.2 bushels for Sokota 220.

In a yield test of 16 experimental double crosses conducted at the North Central Substation in 1953, eight of them proved to be superior to the check, Sokota 220, in yielding ability. Such results indicate that the Experiment Station should soon be able to have several good hybrids for this part of South Dakota.

Taking yield samples and moisture percent from experimental plots of corn

Table 9. Commercial Hybrid Yield Test, McPherson County, 1953

Hybrid or variety	1953 Performance Score*	Acre Yield Bu.†	Moisture %	2-Year Average Yield Bu.	2-Year Average Moisture %	3-Year Average Yield Bu.	3-Year Average Moisture %	4-Year Average Yield Bu.	4-Year Average Moisture %	5-Year Average Yield Bu.	5-Year Average Moisture %
Pioneer 388	108.1	52.2	16.5	37.4	17.5	34.7	34.3	—	—	—	—
Kingscrost KE3	107.8	50.9	13.7	—	—	—	—	—	—	—	—
Jacques 853J	105.2	49.7	15.9	—	—	—	—	—	—	—	—
Sokota 220	105.0	49.5	15.7	39.3	15.7	35.8	31.6	35.4	33.9	—	—
DeKalb 46	103.9	48.4	15.1	34.8	15.9	33.6	32.8	34.2	35.0	—	—
Wisconsin 240	102.6	47.7	15.8	36.5	16.7	36.3	25.3	37.3	27.4	36.3	26.7
Wisconsin 355	102.4	48.1	17.3	33.9	21.1	33.2	35.0	34.8	37.8	—	—
Nodakhybrid 301	102.2	47.4	15.8	—	—	—	—	—	—	—	—
Pride PN16	101.3	46.8	16.1	32.4	18.8	31.0	36.0	—	—	—	—
Hansmann	101.0	47.4	18.4	36.9	17.7	34.9	30.5	37.1	32.3	36.4	30.9
Jacques 901J	100.8	46.9	17.3	—	—	—	—	—	—	—	—
Disco 90W	100.6	47.5	19.5	33.8	22.3	—	—	—	—	—	—
DeKalb 56	100.5	47.7	20.3	37.0	19.5	32.0	36.4	29.9	42.2	—	—
Kingscrost KE2	100.1	45.4	13.9	35.7	13.9	33.8	27.8	33.9	30.7	—	—
Master F21	99.8	45.5	15.7	34.2	16.4	—	—	—	—	—	—
Sokota 212	97.8	45.2	18.9	35.1	19.0	33.2	34.8	33.1	39.1	31.3	38.3
Funks G-188	95.2	41.3	14.0	28.8	17.5	27.8	35.1	28.1	37.7	27.1	36.2
Sokota 204	94.9	42.7	18.3	33.4	19.1	30.0	35.9	29.5	40.1	29.0	40.1
Nodakhybrid 304	93.7	41.6	16.8	35.6	17.6	34.5	30.1	35.9	31.2	35.3	30.4
Silver King	77.6	30.8	22.0	27.2	23.2	25.3	39.9	25.3	42.6	25.8	40.9
Average of all entries		**46.1**	**16.9**	**34.7**	**18.2**	**32.8**	**33.0**	**33.2**	**35.5**	**32.2**	**34.2**

*Varieties are ranked on the basis of the 1953 performance score which is obtained by weighting yield 60 percent and moisture at harvest 40 percent.

†Differences in yield of less than 9.2 bushels per acre are not statistically significant.

Table 10. Single Cross Test, McPherson County, 1953

Entry	1953 Performance Score*	Acre Yield Bu.†	Moisture %	2-Year Average Yield Bu.	2-Year Average Moisture %	3-Year Average Yield Bu.	3-Year Average Moisture %
Sokota 220	108.13	55.1	14.4	36.8	16.4	35.2	30.7
Inbred 1 x Inbred 2	106.82	55.5	18.2	—	—	—	—
" 3 x " 4	105.99	52.7	12.7	40.4	13.3	36.5	27.2
" 3 x " 5	105.56	52.7	13.6	39.2	14.2	37.9	25.3
" 6 x " 4	104.52	52.0	14.0	41.6	15.8	37.3	30.0
" 1 x " 5	103.93	51.1	12.9	—	—	—	—
" 4 x " 5	103.70	51.1	13.4	38.8	14.0	36.4	25.7
" 2 x " 5	103.44	54.4	22.5	40.2	22.7	39.6	31.4
" 6 x " 5	102.94	51.1	15.0	40.5	15.6	39.0	27.8
" 2 x " 4	102.71	51.8	17.3	39.1	22.0	37.4	33.5
" 3 x " 2	101.57	49.1	17.0	40.5	18.7	38.8	30.8
" 6 x " 2	101.06	52.5	22.6	39.6	22.1	37.1	35.5
" 1 x " 4	100.33	48.2	13.0	—	—	—	—
" 1 x " 3	92.91	42.0	12.6	—	—	—	—
" 6 x " 3	82.52	34.0	13.8	26.6	15.0	24.7	30.1
" 6 x " 1	74.89	28.2	14.9	—	—	—	—
Average of all entries		**48.9**	**15.5**	**38.5**	**17.3**	**35.5**	**29.8**

*Varieties are ranked on the basis of the 1953 performance score which is obtained by weighting yield 60 percent and moisture at harvest 40 percent.

†Difference in yield of less than 6.8 bushels per acre are not statistically significant.

Sorghum Yield Trials

SORGHUMS have been grown in South Dakota since 1896. One of the principal reasons for growing sorghums is their adaptibility to hot weather and limited moisture conditions. They are a profitable crop when weather conditions are unfavorable for corn. A 21-year average (1912-32) at the North Central Substation shows that Amber Cane yielded 4160 pounds, corn 3840 pounds, millet 3000 pounds and Sudan grass 2580 pounds of feed per acre.

The orginally introduced grain sorghums needed much improvement. They ripened unevenly, had recurved head stalks that interfered with machine harvesting, were too tall for easy handling and were too late maturing to produce grain.

The weaknesses of these early sorghums have been overcome by plant breeding and selection under South Dakota conditions. There are now available high yielding, early sorghums which produce high quality grain. These include Norghum and Reliance which gave the highest yield as shown in Table 11.

Martin, Midland and Sooner Milo are generally late maturing and are generally killed by frost. This results in low yields of low quality grain. Early Kalo and Improved Coes are intermediate between these two classes, but are not well adapted for the north central area.

Sudan grass has proved to be the best sorghum for pasture or hay purposes in solid seedings. Low hydrocyanic acid canes (Rancher and 39-30-S are the best where a high tonnage of coarse forage is desired. Early maturing grain sorghums (Norghum and Reliance) can help stabilize feed grain production. As a source of forage and feed to support a livestock industry in the drier parts of South Dakota, sorghums can be an important supplement to corn.

Table 11. Yields of Grain Sorghums at Eureka, 1949-52

Variety	1949	1950	1951	1952	4-Yr. Av.
	Bu./A.	Bu./A.	Bu./A.	Bu./A.	Bu./A.
Norghum	30.1	2.8	28.7	21.0	20.7
Reliance	31.8	4.1	34.7	24.9	23.9
Martin	0.7	0.0	0.0	6.6	1.8
Midland	0.5	1.4	0.0	24.9	6.7
Sooner	0.0	0.0	0.0	14.4	3.6
Early Kalo	1.6	0.0	0.7	19.7	5.5
Improved Coes	1.4	0.0	0.7	22.3	6.1

Grasses and Legumes

Establishing Alfalfa in Grasslands

BEFORE THE COMING of the White Man and the white-faced cattle to the ranges of the northern plains country the virgin grasslands comprised a colorful profusion of non-grass plants intermingling with the grasses. A part of the rich panorama of color, variety of vegetative types, and lush plant growth was due to the many wild legumes native to the region.

There are still remnants of these legumes in some pastures and haylands, and their presense is an indication of the superior condition of such grasslands, but, on the whole, their contribution to the total productivity of the range grasses is only a fraction of what it once was.

Can the initial productivity of the grasslands be restored? Yes, by carefully regulated grazing management over a period of many years, much can be accomplished. However, several years are necessary and full utilization cannot be made. It is believed that there may be an alternative procedure.

Reliable evidence from forage experiments began in 1948 at Eureka and from similar experiments at several other locations in South Dakota has indicated that productivity of native grasslands can be greatly increased, perhaps doubled, by establishing a hardy persistent legume in the grassland.

Two considerations are basic to this objective: (1) finding a legume

that, unlike the wild clovers, will be hardy and *persistent when grazed*, and (2) introducing such a legume into grassland without totally destroying the grass itself in the process.

With respect to this second point, it was realized that if the Experiment Station recommended the use of a legume, such as alfalfa, some information as to the methods of getting stands of alfalfa in grasslands would be needed. Accordingly, in 1951 an experiment was laid out at the North Central Substation on upland mixed prairie to compare the value of the following methods of establishing alfalfa in sod:

I shallow plowing of sod
II no treatment
III disking twice without plowing
IV early spring burning of old grass

In each case, the plots (40 by 40 feet) were split into three sub-plots so as to permit sowing three different varieties of alfalfa. About 3 pounds of seed per acre were sown, using a standard grain drill with alternate drill runs covered, and with disk tension adjusted to seed about three-fourths of an inch deep.

The first objective in this trial was to find a treatment which would give an initial set-back to the native grasses, so as to reduce competition with new seedlings of alfalfa in the first few months, but not to eliminate wholly the grasses. In the second and subsequent years it is desireable that the grasses recover sufficiently to maintain more or less permanently a grass-legume mixture of the kind known to be most productive of forage.

Results are discussed in relation to the accompanying figures (4-7).

Observations on the Four Methods Tried

Treatment I (Plowing) See Fig. 4: Germination was good and seedling mortality at a minimum for the experiment. In the fall of the first year, well over 100 plants per plot (12 by 40 feet) could be counted for each variety, and these plants formed healthy crowns as they went into the winter. In 1953, two years after seeding, feather-bunchgrass (*Stipa viridula*) had begun to come back into the plots seeded to Nomad. The Ladak plots were nearly pure alfalfa.

Treatment II (No treatment prior to seeding) See Fig. 5: Germination was poor and seedling mortality high, generally at about the first or second true-leaf stage. Only scattered plants survived the summer and these in many cases were not thrifty enough to form the over-wintering crown needed to survive. Less than 20 plants per plot have persisted during the ensuing two years. These plants in 1954 were vigorous, however, and are making some contribution to the yield of the plots.

Treatment III (Disking) See Fig. 6: Germination was good, seedling mortality much reduced in comparison with Treatment II. Well over 100 plants per plot were observed. Individual plant vigor was restricted and it appeared that some plants

might fail to survive or remain competitive beyond the first winter. By 1953, however, as may be seen in Fig. 6, very good stands had been realized. The stands were sparse enough in the case of Nomad and Sevelra that feather-bunchgrass *(Stipa viridula)* had commenced to come back into the plots. A good understory of native sod was becoming re-established.

Treatment IV (Burning) See Fig. 7: Germination was good and many plants seemed to have made an initial establishment. In early summer, however, as the sod grasses developed, the seedlings began to fail. In October, less than 100 plants per plot could be counted. These were reduced in vigor and it appeared that many would not survive the first winter. A significant number of plants did actually succeed in becoming established, however, and, in 1954, are contributing predominantly to the yield of the plots.

Important Factors to Consider in Establishing Alfalfa in Sod

Results obtained in this test are strictly applicable only under similar conditions of soil fertility, moisture and temperature relationships, and grass competition. These factors vary from location to location and from year to year. It has been observed in several instances that successful stands were obtained by drilling directly into sod. The opposite experience of being unable to get a stand even on firm plowed ground is not too uncommon. The results from this particular experiment then must be interpreted in relation to the environmental conditions. The performance noted in this trial is believed to be sufficiently representative to be useful.

Progressive improvement of vigor has been noted in those cases (Treatments III and IV) where plants were initially reduced in growth and development. The system of management for hay has tended to favor the weak plants. Under a system of grazing, great care would have to be exercised in the early years to permit such plants to become firmly established.

The following conclusions can be drawn from present studies:

1. Moisture reserves must be adequate and seasonal rainfall sufficiently frequent to get new seedlings started and to sustain them through the critical summer months.

2. The desirable perennial grasses must be set back by severe disking or cultivating so as to limit their ability to compete against new seedlings, but they should not be completely eliminated, as by plowing, else the proper mixture most suitable for grazing will not readily be achieved.

3. The variety selected for range planting should possess strong seedling vigor to enable the new plants to become quickly established, agressive root and crown growth being particularly desirable.

4. Once a seeding on the range has been made, its chances of being successful rest clearly upon good management in the first and second years. With present varieties, harvesting the field as hay in the second

or third years will favor the legume. This would be necessary where adequate stands of alfalfa had been obtained but plant vigor reduced due to the competition from the grasses. On the contrary, where the legume was so thick as to seriously inhibit the desirable grasses, a system of judicious grazing would tend to favor the grass at the expense of the legume.

An alternative procedure at seeding time would be to seed both a legume and an adapted grass together. Then a state of balance between the two kinds of plants can generally be more readily achieved.

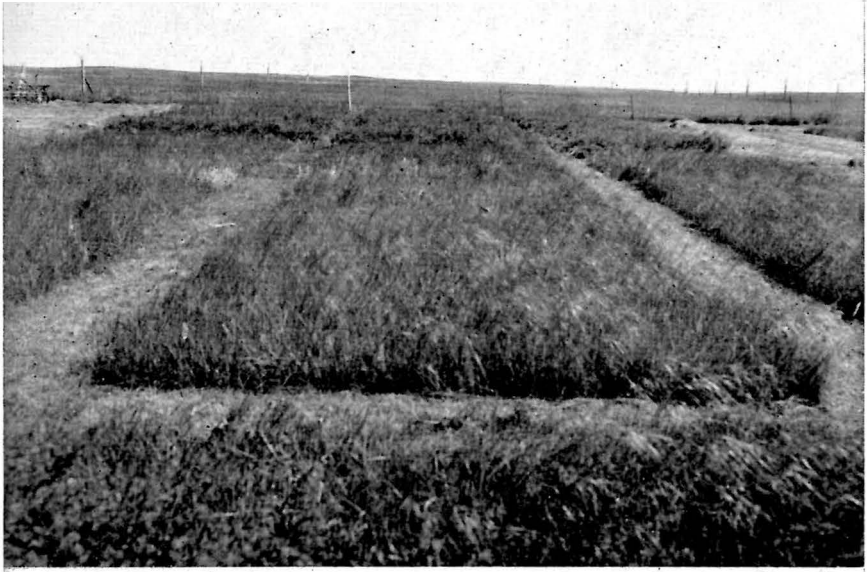
Under the conditions prevailing in this experiment, double disking the sod before seeding resulted in achieving the better balance between alfalfa and native grasses. Ladak was slightly superior to Sevelra and Nomad in ease of establishment, but in the disked plots the additional vigor of Ladak afforded more resistance to encroachment of grasses than could be met with the system of management for hay being employed.

Fig. 4. (Below) Ladak and Nomad alfalfa seeded on plowed sod. Ladak plots are almost pure alfalfa.

Fig. 5. (Top right) Alfalfa seeded with no preparation of sod. A few plants survived the summer.

Fig. 6. (Center right) Ladak and Nomad seeded on disked land. A good stand has been established.

Fig. 7. (Bottom right) Sevelra, Ladak and Nomad seeded on burned land. A significant number of plants survived.



Alfalfa Strain and Variety Trials

BECAUSE OF the more severe winters which generally prevail at Eureka as compared to other areas of the state, it was thought that winter-susceptible types or strains of alfalfa might be more readily recognized by establishing a test nursery at Eureka. Accordingly, the strains listed in Table 12 were seeded in a replicated yield trial in 1950.

The strains differ in winter resistance and reaction to bacterial wilt. Stand losses due to winter injury or to the wilt disease have not occurred up to the present in this test. On the basis of these results (Table 12) the strains do not differ in yielding ability under the prevailing conditions.

On the basis of other trials, comparing the standard hay varieties, the Ladak variety is recommended for hay production in north central South Dakota. It is important to buy only seed of Ladak which has been produced in this northern Great Plains area, and preferably, certified seed.

Table 12. Alfalfa Strain Test at Eureka (Seeded 1950)

Strain	Dry Matter, Tons/Acre (One Cutting Made Each Year on or About July 1)			
	1951	1952	1953	3-Year Average
A 233	1.34	1.50	1.78	1.54
Sevelra	1.30	1.38	2.00	1.56
97-1781	1.27	1.34	2.10	1.57
Wisconsin Synthetic C	1.32	1.28	2.20	1.60
97- C 190	1.45	1.28	2.01	1.58
97-1947	1.42	1.30	2.36	1.69
R-16	1.35	1.25	1.86	1.49
Nomad	1.32	1.30	2.41	1.68
97-1950	1.29	1.21	2.45	1.65
97-1960	1.30	1.34	2.21	1.62
Average yield	**1.34**	**1.32**	**2.14**	**1.60**

Sweet Clover Variety Tests

IN THE PAST few years, several new strains of sweet clover and some miscellaneous legumes have appeared. To evaluate these strains under the soil and climatic conditions prevailing in north central South Dakota, test nurseries were established (Table 13).

Four of the strains listed in Table 13 merit attention at present. Wisconsin Intermediate I, ranking in first place in this test, is a strain developed primarily for its low content of coumarin, the bitter alkaloid chemical in sweet clover which causes the hemorrhagic disease in cattle and sheep. While possessing much vigor in the seedling year, it has failed to come through the winters consistently in other tests and so will not be released as a variety.

Willamette and Evergreen are tall, rank growing strains which are too late in flowering and setting of seed to be reliable seed producers in this area. For straight green manure purposes they have much value, but seed supplies would need to be maintained outside of this region.

Madrid is a vigorous, yellow-flowered type that has good first year development and comes on strongly early in the second year. It is suitable for both pasture and green manure and is early enough to be a reliable producer of seed. For general use in north central South Dakota, Madrid is the best strain of sweet clover available at present.

Table 13. Sweet Clover Variety Trial at Eureka, Seeded 1950, Harvested as Hay in July 1951

Strains	Tons Dry Matter per Acre	Rank
Erector	1.60	8
Alpha	1.23	10, 11
Common yellow	1.63	6, 7
Artic	1.71	5
Wisc. Int. I	1.92	1
Madrid (Foundation)	1.78	4
Evergreen	1.82	3
Grundy County	1.23	10, 11
Redfield yellow	0.51	12
Common white	1.56	9
Willamette	1.89	2
Spanish (Foundation)	1.63	6, 7

Other Legumes

Other legumes, including Birdsfoot trefoil, alsike clover, red clover, and Ladino white clover were seeded in 1950. The first two species named failed outright to become established; red clover and Ladino white clover became established fairly satisfactorily as seedlings, but in the following year appeared to have suffered considerable damage from winter conditions, and failed to survive the summer.

Buildings at the North Central Substation

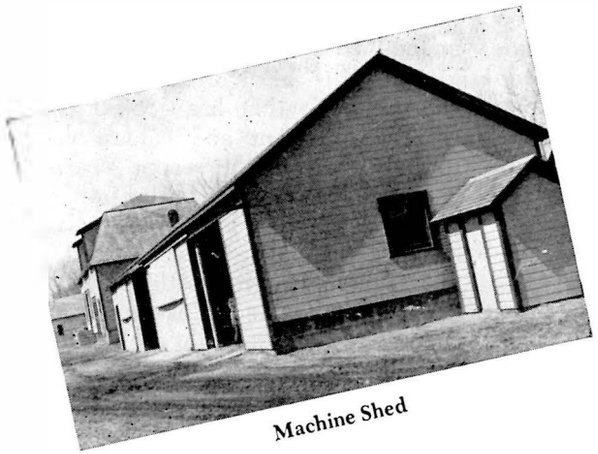
THE BUILDINGS at the North Central Substation consist of a dwelling house, seed house, small general purpose barn, livestock feeding shed and scale house, machine shed and shop, and rammed earth poultry house.

The original buildings, including house, barn and seed house, were built in 1908 and 1909. More recently, the poultry house was constructed in 1938, the livestock shed in 1948 and the machine shed in 1949.

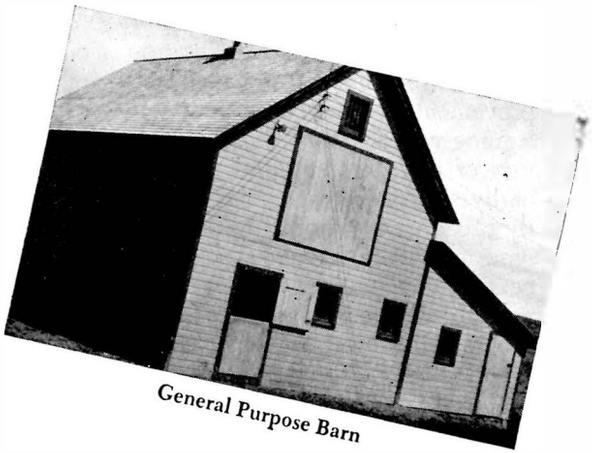
The rammed earth poultry house is the only structure built for experimental purposes with respect to building materials. It was one of the six buildings constructed in the rammed earth research project carried on by the Agricultural Engineering Department from 1929 to 1940.

This building is 20 by 40 feet in size, has a two-thirds span roof, and has windows and ventilator on the south side. The ceiling is insulated. The rammed earth walls were left exposed to the weather until 1952, when a cement stucco coat was applied. Most rammed earth structures were stuccoed either the first or second year, but the poultry house stood for more than 10 years without a protective coating and showed very little weathering.

The construction of the poultry house was done by a crew of CCC boys from the Eureka community under the direction of Mr. Jacob Weller, who obtained the proper tools, equipment, and building instructions from State College. The building was placed on a reinforced concrete foundation, 14 inches thick. The entire wall structure was of 14-inch monolithic rammed earth, except for door and window openings and gable ends. Even the floor was made of tamped soil cement mixture over a coarse gravel fill base. The house has been in constant use for chickens or turkeys since it was built and is in good condition at the present.



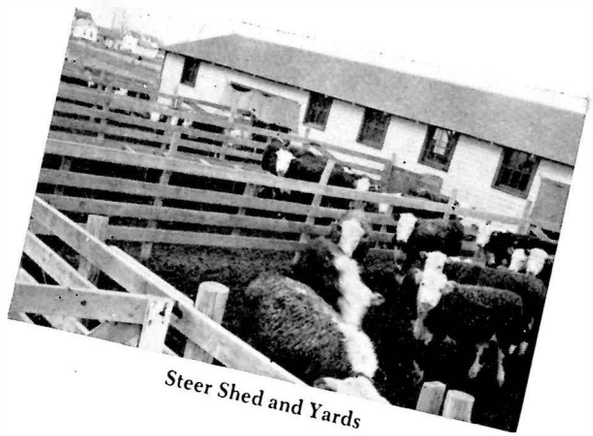
Machine Shed



General Purpose Barn

Poultry House (left) and Machine Shed

Farm House at Eureka



Steer Shed and Yards

Grazing Persistence Studies

ONE ASPECT to the over-all program of grassland or range improvement has to do with finding a legume which, unlike the wild clovers of the virgin prairies, will be hardy and *persistent when grazed.* By breeding it is hoped to develop types of alfalfa having special fitness for the conditions of our range pastures. In the present stage of the program, however, it is important to evaluate the performance of standard hay types when grazed. Accordingly the following trial was undertaken.

In early spring of 1951, on native upland prairie just plowed, 15 strains of alfalfa were seeded in replicated plots 5 by 40 feet in size. Perfect stands of all strains were obtained and during the year of establishment the area was closed to livestock. In 1952, a herd of cattle had continuous access to the area for three weeks, commencing the middle of June, and again for a somewhat shorter period in the latter part of August. When the plots were inspected in October, 1952, no regrowth had taken place on any of the plots. All strains had been grazed down to the ground level.

In 1953, spring recovery was satisfactory on most of the plots, though certain ones were diminished in stand and irregular in vigor. Two strains had suffered almost complete winter injury (Chilean and Pilca Butta). Commencing June 10, 1953 the stock was permitted access to the plots for a 3-week period, and at the end of this time observations were made and recorded.

It is extremely difficult to measure quantitatively the effects of grazing upon alfalfa strains unless the experimenter is able to keep the test under daily observation. In this case, reliance was placed upon field observations with respect to vigor and stand (Table 14).

Survival and maintenance of plant vigor over several years must be the final test by which the relative performance record of each strain is based. At the present time the strains in Class I appear definitely superior with respect to these characteristics. It would be premature to state that these strains will continue to stand up under grazing as practiced with this test.

For those strains in Classes IV and V, it can be stated with considerable confidence that they are definitely not suited to grazing. The Strains in Classes II and III do not appear to be well adapted to grazing for the reason that they do not combine high vigor with persistence, even though for either one of these characteristics alone they might be satisfactory.

Table 14. Effects of Grazing on Vigor and Stand of 15 Alfalfa Strains at Eureka

Strain	Comments (From Notes Taken July 1, 1953)
Class I	
Bison composite	excellent vigor, excellent stand, crowns healthy and regenerating.
Rhizoma	excellent vigor, excellent stand, crowns healthy and regenerating.
Ladak	excellent vigor, excellent stand, crowns healthy and regenerating.
Bison bulk	excellent vigor, excellent stand, crowns healthy and regenerating.
Class II	
Medicago falcata	good vigor, good stand, growth and recovery retarded but persistence has been good.
Nomad	fair vigor, good stand, persistence has been good.
Semipalatinsk	good vigor and persistence.
Class III	
Sevelra	good vigor, good stand.
Ranger	fair vigor, fair stand.
Class IV	
Buffalo	low vigor, stand adequate but plants much weakened, crown narrow, and showing little initiation of new growth.
Grimm	much weakened, many plants dead from grazing injury.
Cossack	much weakened, many pants dead or dying from grazing effect.
Class V	
Talent	all plants severely weakened, many plants dead.
Chilean	all plants dead, due primarily to winter injury.
Pilca Butta	nearly all plants dead, a result of the joint effects of grazing and winter injury.

Grasses and Legumes

Grass Variety Trials

TO DETERMINE the highest yielding grasses under conditions existing in the north central area of the state, a test of adapted grasses was seeded in 1948 at Eureka. The yielding ability of these grasses when in mixture with other grass and alfalfa was tested by planting them according to the plan shown in Fig. 8. The eight grasses were planted in plots 7 by 80 feet in each one of the four replicates. In each replicate each grass was grown alone, with creeping red fescue, with alfalfa, and with both creeping red fescue and alfalfa.

Good Stand of Grasses Obtained

A good stand of all grasses was obtained. Mandan wild rye, though a very good stand at first, has become invaded by other grasses so that yields reported in the last years include these grasses. Slender wheatgrass has tended to decrease in stand somewhat, but not to the extent of Mandan wild rye. Other grasses such as bromegrass, crested wheatgrass, Ree wheatgrass, Green Stipagrass and Russian wild rye maintained their stand and resisted the invasion of other grasses.

Replicate III	Replicate IV
Grass with alfalfa and creeping red fescue	Grass alone
Grass with creeping red fescue	Grass with alfalfa
Grass alone	Grass with alfalfa and creeping red fescue
Grass with alfalfa	Grass with creeping red fescue
Grass with creeping red fescue	Grass alone
Grass with alfalfa and creeping red fescue	Grass with alfalfa
Grass with alfalfa	Grass with creeping red fescue
Grass alone	Grass with alfalfa and creeping red fescue
Replicate I	**Replicate II**

Fig. 8. Plan for an experiment to test yielding ability of grasses alone and in mixtures

Yields

The average yields of the grasses in this test for the 5-year period, 1949-53, are reported in Table 15. Ree wheatgrass, standard crested wheatgrass, Homesteader brome, and Green Stipagrass were the highest yielding grasses during these years. Ree wheatgrass in years of abundant rainfall, such as in 1953, makes a very high yield, reflecting its ability to produce abundant forage when conditions are favorable. The high yield obtained that year gave this grass the highest average for the 5-year period. Red fescue

Table 15. Average Yield of Grasses Alone and of Mixtures for the 5-Year Period, 1949-53

	Alone	With Creeping Red Fescue	With Alfalfa	With Alfalfa and Creeping Red Fescue
	T./A.	T./A.	T./A.	T./A.
Ree wheatgrass	0.53	0.35	1.16	0.93
Homesteader brome	0.44	0.39	1.07	0.87
Standard crested	0.43	0.32	1.12	1.07
Green Stipagrass	0.43	0.36	1.33	1.03
Mandan wildrye	0.42	0.23	1.34	0.81
Slender wheatgrass	0.37	0.27	1.19	0.84
Russian wild rye	0.26	0.18	0.83	0.67
Creeping red fescue	0.21	0.17	0.88	0.71
Average	**0.33**	**0.28**	**1.12**	**0.87**

gave the lowest yield while Russian wild rye was only slightly higher. Slender wheatgrass had a very strong seedling and made a good showing the first year, but fell off rapidly in yield the following years.

Yields of each of these grasses in mixtures are also shown. When grown with creeping red fescue, the more vigorous competitive grasses such as Homesteader brome, Green Stipagrass, Ree wheatgrass and standard crested yielded the most, while Russian wild rye and slender wheatgrass gave poorer yields. In each case, the addition of the creeping red fescue depressed the yield.

When the grasses were grown with alfalfa quite another effect was found. The yield of the mixture of each grass with alfalfa was much higher than the grass by itself. Though alfalfa may in some circumstances yield as much by itself as in combination with grass, alfalfa alone cannot be recommended over a mixture with grass. A better balanced ration is provided when grass is present with alfalfa. For this reason, a mixture of grass and alfalfa is preferable to either by itself.

When creeping red fescue was added to the grass-legume mixture, the yield was lowered. In this situation the standard crested wheatgrass and Green Stipagrass have yielded better than the other mixtures.

It may be concluded from this experiment that (a) Ree wheatgrass, Homesteader brome, standard crested and Green Stipagrass may be recommended for their yielding ability, (b) the addition of a low-yielding grass to a mixture lowers the yield as is shown by the over-all averages at the bottom of Table 15 and (c) alfalfa-grass mixtures yield two to three times as much forage as the grass grown by itself.

Bromegrass Varieties From Different States Tested

Varieties of bromegrass originating from different states in the bromegrass growing area were tested to find if there were any varieties especially adapted to local conditions. This same test has also been established at many locations in other states. At Eureka, Ree

wheatgrass was included in the test. The data obtained during the years 1951-53 indicate that Ree wheatgrass yielded slightly more than any of the bromegrass varieties. Homesteader, Lincoln, Achenbach, Lancaster, Elsberry, Lyons, Manchar and Martin have yielded near the top each year. Homesteader was originated under South Dakota conditions and for that reason can be expected to give the best performance in most seasons.

Table 16. Average Yields of Bromegrass Varieties for the Three-Year Period, 1951-53

	T./A.
Ree wheatgrass	0.75
Lincoln	0.67
Homesteader	0.65
Achenbach	0.65
Lancaster	0.64
Elsberry	0.62
Lyons	0.61
Manchar	0.61
Martin	0.60
Fischer	0.54
Storley	0.52
Mandan 404	0.50
Canadian	0.49

Grasses and Legumes

Frequency of Cutting

To determine how frequently native hay should be cut to get good yields of high quality hay and yet leave the grassland in good condition, 18 plots, each two rods square, were laid out in 1942. The plots were randomized and some were cut for hay every year, others once in two years and still others only once every three years. Results obtained are shown in Table 17.

On a yearly basis, the average yield was the highest from plots harvested every year. However, on these plots annual weeds were increasing and replacing some of the native grass. Those plots cut once in three years produced much less hay and of poorer quality.

To determine the quality of the hay, protein determinations were made on the hay harvested for three years. The protein data are reported in Table 18.

Hay obtained from the plots cut each year possessed the highest protein content. The hay cut from plots cut once every three years contained dead grass from previous years growth and had less protein (7.04

Table 17. Yields of Native Hay According to Frequency of Cutting, Eureka, 1942-53

	Each Year	Every 2 Years	Every 3 Years
	Lbs./A.	Lbs./A.	Lbs./A.
Yields at harvest	1335	2284	2594
On yearly basis	1335	1142	865

Table 18. Protein Content of Native Hay According to Frequency of Cutting, Eureka, 1949, 1952, 1953

Frequency of Cutting	Percentage of Protein
Each year	9.02
Every 2 years	7.71
Every 3 years	7.04

percent). When considering the increased weed infestation and harvesting costs, in relation to the average yields and protein content, it appears that harvesting native hay (largely western wheatgrass), every two years is best and aids in the maintenance of high yields.

Showing the one-, two-, and three-year cuttings when the harvest of each of the three plots are stacked together

A. Dittman, superintendent, talking over a feeding experiment with neighboring farmers

Grasses and Legumes

Feeding Value of Prairie Hay

Cut at Three Different Stages of Maturity

DURING MOST YEARS in South Dakota much native grassland is harvested for hay. This crop makes up a major portion of the total annual feed supply for cattle and sheep in the state. The harvesting season often extends from late June into October, and, until rather recently, little consideration has been given to the effect of time of harvesting upon the chemical composition and feeding value of this hay. Since the grass appeared to stand up well, the opinion was commonly expressed that no serious loss in feeding value occurred as it matured.

Experiments Designed to Find Best Time to Harvest Prairie Hay

Experiments were conducted to determine the effect of time of harvesting on the chemical composition and feeding value of prairie hay, since little information was available regarding this important crop. The work was conducted at the substations at Eureka, Cottonwood, and Highmore, and at Brookings.

The three stages of maturity selected for harvesting were heading (early), seed ripe (medium), and mature and weathered after frost (late). The stage of maturity of the dominant species was used to determine the cutting date. Early-cut hay

was usually harvested during the first half of July, medium-cut hay during the latter part of August, and the late-cut hay during late September or early October.

When needle-and-thread was present in sufficient quantity to cause trouble from the needles, harvesting of the early-cut hay had to be delayed until most of the needles fell. In some years this caused the harvesting to be done later than was desirable for the best test of the early cutting. The experience at this Station has been that when hay containing many needles is fed to calves, they will not eat enough of this hay to gain any weight.

Early-Cut Hay Has Highest Feeding Value

Several samples of hay were analyzed each year to determine the effect of stage of maturity upon the chemical composition. A summary of analyses made on several samples from the three substations is given in Table 19.

There was a serious decline in the protein and phosphorus content of the hay as it matured. Other nutrients shown in this table did not change appreciably. Since both protein and phosphorus are expensive portions of livestock rations, the loss means a decided reduction in the value of the hay with advancing maturity.

Digestion trials with steer calves were conducted at Brookings each year, using hay brought in from one of the substations. The results of two of these trials with hay from Eureka are shown in Table 20.

Apparent digestibility of the protein and total dry matter decreased with each successive cutting stage. The decrease was much greater in the case of protein. These digestion coefficients were used to calculate the total digestible nutrients (TDN) and digestible protein from the chemical composition given in Table 19. Early-cut hay contained more total digestible nutrients and digestible protein than the other cuttings. The differences in digestible protein were especially great. The late-cut hay furnished a very small amount of digestible protein for the cattle.

Table 19. Average Chemical Composition (Percent) of Prairie Hay Cut at Various Stages of Maturity (Samples Taken 1947, 1948, 1949, 1950)

	Stage of Maturity		
	Early	Medium	Late
Number of samples	36	34	35
Dry matter	91.25	91.57	91.02
Crude protein	7.43	6.11	4.94
Ether extract (fat)	2.66	3.24	3.35
Crude fiber	29.23	29.64	30.30
Nitrogen-free extract	43.11	43.91	43.50
Ash	8.82	8.71	8.93
Calcium	0.29	0.31	0.32
Phosphorus	0.19	0.13	0.09

Table 20. Average Coefficients of Apparent Digestibility (Percent) of Prarie Hay Cut at Different Stages of Maturity (Average of Two Trials with Steer Calves)

	Stage of Maturity		
	Early	Medium	Late
Dry matter	47.1	43.5	39.4
Crude protein	42.6	30.6	9.3
Ether extract (fat)	40.0	29.3	34.7
Crude fiber	59.1	54.8	52.9
Nitrogen-free extract	49.4	47.4	43.2
Total digestible nutrients (TDN)	44.12	41.06	37.89
Digestible protein	3.17	1.87	0.46

Supplementing Hay Based Upon Its Protein Content

Results of the chemical analyses and digestion trials, along with feeding trials, pointed to the need of a greater amount of protein supplement to be fed with the hay harvested in the medium and late stages of maturity. The large acreage to be harvested and work pressure from other sources, such as small grain harvest, often make it difficult to harvest all the hay at the proper time. Feeding a protein supplement at the same rate when the hays vary widely in protein content no doubt results in overfeeding in some cases and underfeeding in others. The net effect is inefficient and uneconomical use of the hay and supplement.

Therefore, in the fall of 1950, feeding trials were designed to determine the performance of calves wintered on hay cut at three stages of maturity when all cuttings were supplemented with soybean meal pellets to give an equal amount of protein in all rations. A level of 10 percent total protein was selected as a desirable amount. Satisfactory and uniform gains were obtained at this level of protein and it was used throughout the three years of this study (1950-53).

Calves for each trial were purchased in October from auction markets about one month before being placed on the experiment. Vaccination for blackleg and spraying for lice and grub control were carried out each year. When the experiment began, the calves were fed all the hay they would clean up without undue wastage and enough soybean meal pellets to give approximately 10 percent protein in the total ration. Salt and bonemeal were fed free choice. Both steers and heifers were used in the first two trials but only steers in the last one.

Results of the Tests

A summary of the three trials at the North Central Substation is shown in Table 21.

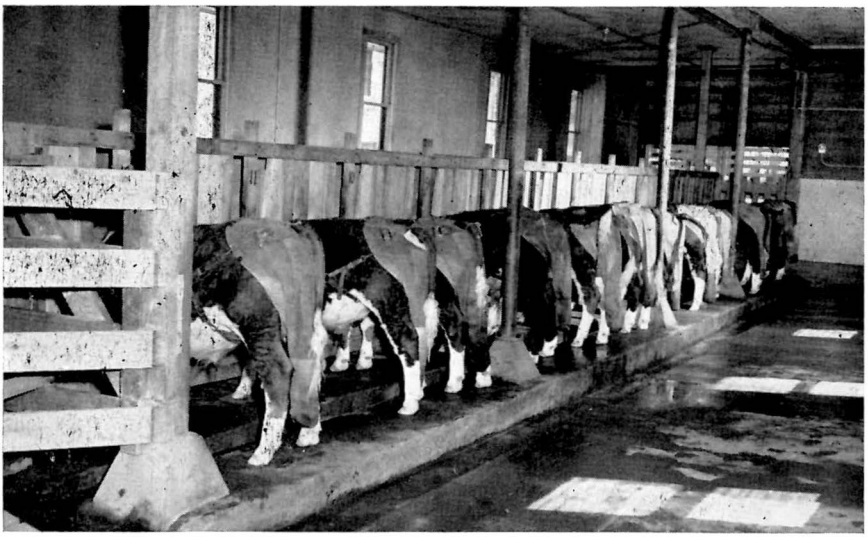
When each hay was supplemented with enough soybean meal pellets to give about 10 percent protein in the ration, there were only slight differences in the rate of gain between the three lots of calves in any year. The average gain for the three trials was nearly one pound daily

One lot of calves fed in the 1952-53 trial. Note the v-bottom feed bunk. This type is desirable when feeding a small amount of pellets since they all roll to the bottom center of the feed bunk

Table 21. Feeding Results with Hay Cut at Three Stages and Supplemented with Soybean Meal Pellets to Give About 10 Percent Protein in Total Ration

	Early-cut Hay	Medium-cut Hay	Late-cut Hay
Total number of calves	29.8*	30	29.7*
Average number days fed	140	140	140
Average initial weight, lbs.	422	423	420
Average gain per calf, lbs.	128	137	136
Average daily gain, lbs.	0.92	0.98	0.97
Average daily ration, lbs.			
Hay	12.2	12.8	12.7
Soybean meal pellets	1.18	1.66	2.03
Feed per 100 lbs. gain, lbs.			
Hay	1332	1308	1303
Soybean meal pellets	128	169	208
Protein content of hay, %	7.24	6.11	4.72
Protein content of ration, %	10.2	10.1	9.7
Supplement fed per ton of hay, lbs.	192	258	320

*One calf in the early-cut hay lot died and one in the late-cut hay lot was removed before completing the trial.



Calves such as these were used at Boookings to determine the digestible nutrients in the hay cut at the Substation. This unit is also being used to find out the kind of supplements needed with prairie hay

for each calf. A daily gain this high is sufficient for wintering calves that are to be pastured the following summer without pasture feeding.

The gain made by the calves fed early-cut hay and 1.18 pounds of protein supplement was slightly less than gains made by the calves fed hay cut later but with a greater amount of protein supplement. Supplementing in this manner to equalize the protein content of the rations at the 10 percent level also increased the total digestible nutrients with each increase in the amount of soybean meal pellets used. This probably accounts for the slightly greater gain with the medium- and late-cut hays. However, these hays were lower in TDN but not to the same degree as they were in protein (Table 20).

The average protein content of the hays over the three years is quite similar to that shown in Table 19. While the variation between the different cuttings may not appear great, this variation made a considerable difference in the amount of protein supplement required per ton of hay. Sixty-six pounds more of protein supplement were required per ton of hay when feeding the medium-cut hay than when feeding the early-cut. Late-cut hay required 128 pounds more supplement than the early.

Since rate of gain and hay requirements were about the same, the important difference between the various cuttings was in the amount of supplement required. The extra value of the early-cut hay, based upon the difference in amount of

hay, can be determined readily from this experiment. If soybean meal pellets sell for $100 per ton, or 5 cents per pound, then the early-cut hay was worth $3.30 more per ton than that cut at a medium stage of maturity (66 lbs. x $.05 = $3.30). It was worth $6.40 more per ton than the late-cut hay (128 lbs. x $.05 = $6.40).

Interpreting the Results

The results mean that prairie hay should be harvested at an early stage of maturity and before the small grain harvest in order to obtain its greatest value. By doing this, more protein from the hay is saved and the need for protein supplements is reduced. However, hay is not always harvested at the best time. It often has wide variations in quality and feeding value. These results show that by considering the quality of the hay and supplementing accordingly, the most efficient and economical use can be made of both hay and supplement.

At the present time, protein content appears to be the best single indication of the value of prairie hay. Protein content is influenced by stage of maturity when harvested. Therefore, in the absence of a known protein content, stage of maturity when harvested can be used as an indication of the value of the hay, provided it has been properly handled and not weathered during harvest.

In this experiment, gains of nearly one pound per calf daily were obtained on early-cut hay by feeding 1.18 pounds of soybean meal pellets daily or 192 pounds per ton of hay. Gains of about the same rate were obtained when feeding the medium-cut hay and 1.66 pounds daily of the protein supplement or 258 pounds per ton of hay. When late-cut hay was fed, the daily requirement of protein supplement for this rate gain was 2.03 pounds, or 320 pounds per ton of hay.

Garden Vegetables and Fruits

Garden Vegetables and Fruits

Vegetables

EACH YEAR at the North Central Substation there has been a home garden with a wide variety of vegetables. It has shown consistently that the investment of a few dollars and some spare hours is worthwhile. Not only has it contributed a substantial saving in the yearly food bill, but it has also added vitamins and minerals to the diet which might otherwise have been lacking.

Some vegetables do best when the seeds are planted indoors and later transplanted to the garden. This is usually done with cabbage, cauliflower, head lettuce, tomatoes, and peppers. The important considerations in transplanting are to have healthy plants and plants of the proper age. Before being set out in the garden the plants should have plenty of sunlight and water.

Most vegetable seed should be treated before planting to insure against damping off, a common disease attacking seedlings. There are a number of preparations available, such as Arasan, Spergon, and Phygon which can be safely used for nearly all vegetable seeds. The instructions on the container, however, should be consulted to determine its suitability for the crop in question.

Potatoes, onions, winter squash, carrots, rutabagas, and late cabbage may be grown in large amounts for winter storage. By proper storage and by freezing a number of vegetables, a wide variety can be had during the winter. Recommendations for the area around Eureka are made in Table 22.

Garden Vegetables and Fruits

Fruit Plantings

THE PLACE selected for a fruit planting at Eureka is a gently rolling site with northern exposure. This affords some protection from summer heat and wind and may delay blossom opening a few days. Trees were planted on the contour with terraces at frequent intervals. Plantings of wind-protecting shrubs were made at strategic locations to serve as snow catches and thus add to the reserve moisture. Clean cultivation was followed each summer. As a result of these practices the trees have made good growth, have produced well and suffered little from lack of moisture.

The fruit trees planted were largely from varieties developed at the South Dakota Experiment Station.

Table 22. Vegetable Garden Recommendations for Eureka

Crop	Recommended Varieties	Planting Date (Outdoors)	Insect Pests	Control	Storage	Age of Plants for Setting Outdoors
ASPARAGUS	Mary Washington	April 30	Asparagus beetle Cutworms	Rotenone Chlordane on soil	Freezing	
SNAP BEANS	Topcrop	May 10			Freezing	
WAX BEANS	Pencil-pod Black Wax	May 10				
BEETS	Detroit Dark Red Crosby's Egyptian	May 2				
CABBAGE	Early-Golden Acre Late-Wis. All Seasons	May 2 May 10	Cutworms Maggot Cabbage Worms	Chlordane on soil Chlordane on soil DDT Rotenone	32°, high humidity	4-6 weeks
CAULIFLOWER	Early Snowball	May 2	Cutworms Maggot Cabbage Worms	Chlordane on soil Chlordane on soil DDT, Rotenone	Freezing 32°, high humidity	5-7 weeks
CARROTS	Red Cored Chantenay	May 1			Freezing 32°, high humidity	
CUCUMBERS	Slicing—Marketer Pickling—Mincu	May 20 May 20	Cutworms Cucumber beetles	Chlordane on soil Rotenone		
LETTUCE	Leaf—Salad Bowl Head—Great Lakes Pennlake	May 1	Leaf Hoppers	DDT, Rotenone		6-8 weeks
LIMA BEANS	Not a dependable crop in this area.					
MUSKMELON		May 10	Cutworms Cucumber beetles	Chlordane on soil Rotenone		
ONION	Seeds—Early Yellow Globe Sets—Ebenezer Transplants—Yellow Sweet Spanish	May 10 May 10 May 10	Thrips Cutworms	DDT Chlordane on soil	32°, dry	

Warning: Do not apply DDT or Chlordane dust within 30 days of harvest. Recommended concentrations are 5 percent DDT dust, 5 percent Chlordane dust, and 1 percent Rotenone dust.

Table 22. Vegetable Garden Recommendations for Eureka (Continued)

Crop	Recommended Varieties	Planting Date (Outdoors)	Insect Pests	Control	Storage	Age of Plants for Setting Outdoors
PEAS	Little Marvel Lincoln (later)	May 2	Leaf Hopper	DDT	Freezing	----
PEPPERS	Vinedale Calwonder (later)	June 1	Cutworms	Chlordane on soil	Freezing	8 weeks
POTATOES	Red Warba (early) Early Ohio	May 1	Colorado potato beetle Leaf Hoppers Flea beetles	DDT DDT DDT	50°	----
RADISH	Scarlet Globe	May 10	Maggot Flea beetles	Chlordane on soil DDT	----	----
RHUBARB	Canada Red MacDonald	April 30	----	----	Freezing	----
RUTABAGA	American Purple Top (yellow)	June 20	Flea beetles	DDT	32°, high humidity	----
SPINACH	Viking, America	May 10	Flea beetles	DDT, Rotenone	Freezing	----
SQUASH	Summer—Cocozelle Winter—Butternut Buttercup	May 20	Cucumber beetles	Rotenone	----	----
SWEET CORN	Golden Rocket (early) Carmelcross	May 1 to July 1	Cutworms Corn earworm European corn borer	Chlordane on soil DDT on fresh silks DDT	Freezing	----
TOMATO	Siouxann, Sioux Firesteel, Bounty	June 1	Hornworms, Flea beetles, Fruitworm, Cutworms	DDT, Chlordane on soil	Canning	6-8 weeks
WATERMELON	New Hampshire Midget, Rhode Island Red	June 1	Cucumber beetle	Rotenone		

Warning: Do not apply DDT or Chlordane dust within 30 days of harvest. Recommended concentrations are 5 percent DDT dust, 5 percent Chlordane dust, and 1 percent Rotenone dust.

Orchards in 1941 after trees were planted

Plums, plum-sandcherry hybrids, sandcherries, apricots, apples and crabapples were included in the test. After 12 years of observations, certain conclusions can be drawn regarding home fruit growing in the north central part of the state.

Sandcherries

The sandcherries were named varieties budded on plum root stocks and one-year-old seedlings. Both produced fruit of acceptable quality according to the local people. They produced fruit one year after planting and reached their peak of production the third year. Yields ranged from 2 to 16 pounds, with an average of 7 pounds per plant. After three years the plants lost vigor and yields declined to a point where after eight years little fruit was produced. All plants were removed in 1953. This is a short-lived plant and will need to be replanted about every five years. Eight to ten plants will supply the average family. When budded varieties are not available seedlings may be planted.

Plum-Sandcherry Hybrids

The plum-sandcherries are perhaps the most practical fruit trees for a home planting. All 13 plum-sandcherry hybrid plants were about equal in vigor and winter hardiness. The fruit quality was quite different. Sapa was generally rated a favorite because of the red flesh and dark red juice. The green flesh or Opata made this variety less attractive, but otherwise it was generally considered good. These two varieties are perhaps the two best for the area. The second season after planting, considerable fruit was produced, and their peak of production was reached by the fifth year. The fruit is good as a fresh fruit or for jam and preserves. Five or six plants are enough for an average family.

Plums

Twelve varieties of plums were planted. Those which were selections from the wild plums were the most productive. For this type of plum, the variety South Dakota is one of the best. Although the fruit lacks the quality of some of the better varieties, it is good for cooking purposes. In addition, it has a long bearing season due to uneven ripening. For dessert purposes, the

largest, and frequently considered the best, is Kahinta. Also, Kaga and Kota are rated highly as a quality fruit. These three varieties are among the best planted in this orchard. One plant of each will provide an adequate supply.

The greatest problem experienced with this planting of stone fruit was virus disease. The only known control is to start with disease-free stock and isolate the planting from other stone fruits. Most of the plants were badly infected by the fifth year.

Apricots

The apricots planted were seedlings from the hardy Manchurian strain. The trees have been vigorous and have served well as a wind protection for other trees. Production has not been dependable because of spring frost damage, and it is questionable if apricots should be included in a fruit planting for the north central area of the state. The trees break easily when covered with ice and have shown much frost damage. They are beautiful when in blossom and may be included for their ornamental value. Also, the fruit makes a sauce of fair quality.

Apples and Crabapples

It was thought that apples would not do well at the North Central Substation. For that reason, only varieties of know hardiness were planted. No varieties of good dessert quality were planted, so most of the fruit has been of value for cooking only. Transparent, Anoka and Duchess have produced well and been dependable varieties. Five or six trees should be enough for a family supply. The growth of trees has been good enough to justify the belief that other varieties of better eating quality can be grown.

In 1948, six varieties of high quality eating apples were added in this

The same orchard in 1953 after 12 years

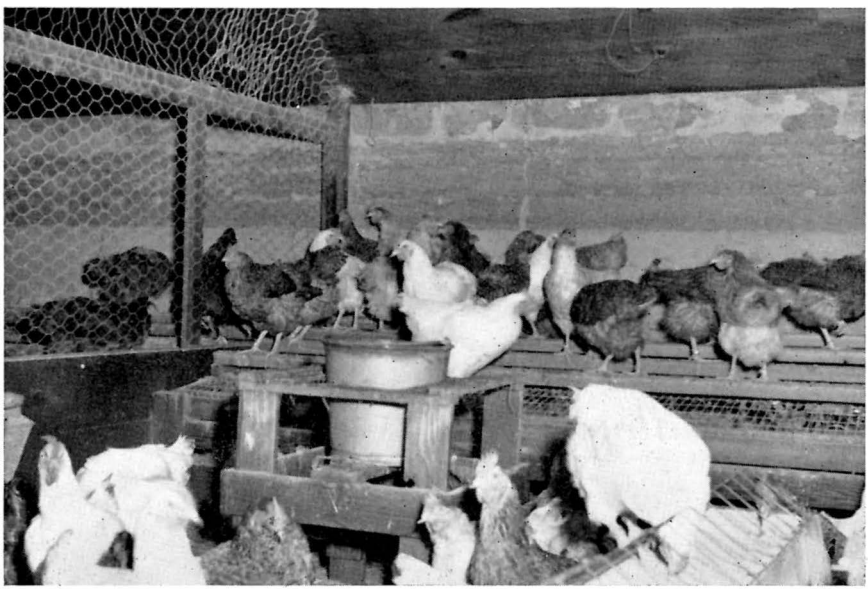
orchard. To date, they have not produced fruit, but growth has been good and they should soon start to bear. Wealthy, Minjon, and Haralson look promising and will likely be about the best varieties for planting. Such a combination of varieties will give a long season of fruit for fall and winter storage.

All the crabapples have produced well. Alexis, Dolga and Whitney have been very productive and should be included in the home fruit planting. Alexis and Dolga are so much alike that it makes little difference which is planted. Since the chief use is for jelly, one tree should be adequate.

Perhaps dropping of the fruit has been the greatest problem with the apple crop. While no attempt has been made to control dropping, it can be prevented and has been successfully done at the Main Station by spraying the tree with a "hormone-like" material. Napthalene acetic acid, sold under various trade names, applied just as the fruit starts to drop will prevent fruit dropping.

It should be mentioned that this orchard has not been troubled seriously by insects or diseases even though no spraying has been done. Also very little pruning has been done. These are jobs which are ordinarily negelected in many home fruit plantings. It appears that much fruit can be produced with a minimum of care, and there is ample reason to support the belief that a supply of fruit for home use can be grown in the north central area of the state. Wind protection, clean cultivation and selecting the right varieties should be considered.

The rammed earth poultry house before a stucco coat was applied. Standing in front of the building is Jacob Weller, who supervised the building of the house in 1938



Interior of the poultry house which will accomodate four pens of 55 pullets each

Poultry

Poultry

Breeding and Management

WORK WITH TURKEYS at the North Central Substation has been carried on for the past 15 years and a project with laying hens has been under way for the past 7 years. These trials have been conducted with fairly small numbers of birds, using houses and equipment that might be practical under many farm conditions.

Dubbed Pullets Give High Winter Egg Production

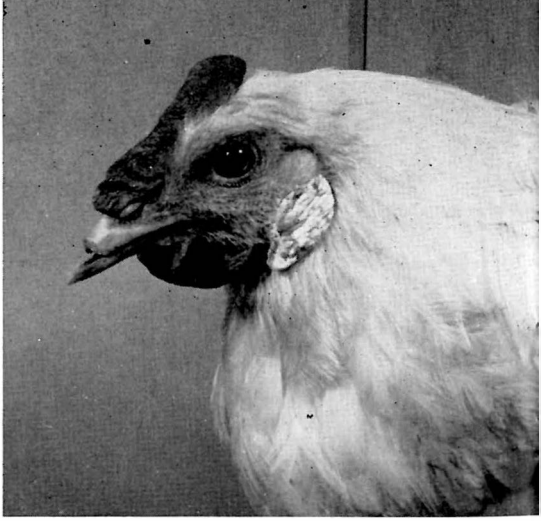
For two years, trials were conducted comparing egg production of dubbed and normal White Leghorn pullets. The dubbed pullets had their combs and wattles removed at housing time, before egg production had begun. There did not seem to be any difference in mortality or *annual* egg production between the dubbed and normal birds. However, the pullets that had been dubbed seemed better able to withstand the low temperatures of January and February than did the normal birds, as each year the egg production was highest in the dubbed pens for these two months. The amount of the difference in winter egg production was greater during 1949 than in 1948. Weather data show that considerably lower temperatures were experienced in 1949 than in 1948. A dubbed and a normal bird toward the end of the laying year are shown in the illustration on page 56.

Debeaking Reduces Cannibalism

While dubbing of females has not been widely practiced, these results would seem to show that Leghorn type pullets, whose combs and wattles have been removed, would probably lay more winter eggs in northern South Dakota than normal pullets of the same type. Size and type of poultry house would, of course, have a bearing on the expected results.

Each year the pullets housed at the Substation have been debeaked at housing time (see illustration). This is done by removing about half of the upper beak with an electric debeaking machine. The purpose of this operation is to reduce cannibalism in the flock. This method of control seems to be the most effective of several that have been tried.

Normal White Leghorn pullet, debeaked



Dubbed White Leghorn pullet, debeaked

Poultry Performance Tests

SINCE 1947 the rammed earth poultry house has been used for testing chickens produced by different breeding methods. The pullets are hatched and grown at the Experiment Station at Brookings and are transported to Eureka about October 1 each fall. The poultry house will accommodate four pens of 55 pullets each. All pens are fed and managed alike so that any difference in performance would be attributed to the breeding behind the birds.

Each pen is supplied a 20 percent protein mash and grain, free choice, fed in troughs. Water and oyster shells are supplied and morning lights are used from October to April so as to provide about a 13 to 14 hour "working day." All pullets are debeaked. No culling is done, since removal of non-laying birds would tend to mask some of the differences being measured. Any birds which become broody are placed in a broody coop for four or five days and are then returned to their respective pen.

The following records are kept: daily egg production by pens, mortality, body weight, and number of broody periods. Each year's trial is continued for a period of ten or eleven months, allowing time for cleaning and disinfecting the house for the following group of pullets.

Reasons for Current Interest in Poultry Breeding Methods

There are really two main reasons for the current interest in new poultry breeding methods. The method involving pedigree breeding and family selection has seemed to result in little or no progress in recent years. It has often been typical of such stock that egg production of individual birds in a flock varies widely.

At the present time there are several agencies producing and dis-

tributing commercial hybrid chickens. Inbred lines are developed by several generations of full brother-sister matings coupled with rigid selection. These inbred stocks are then combined in two-way, three-way, or four-way combinations to produce a commercial chicken. Such chickens are often referred to as "hybrids."

When inbred males are mated to non-inbred females, the offspring are often called "topcrosses." Sometimes males produced by crossing two inbred lines are mated to non-inbred females. The chicks from such a mating are referred to as a "single-cross topcross." If several inbred lines are available, the number of possible combinations that might be worked out is almost without limit.

Experience to date indicates that not all inbred lines or combinations of them give improved results. Some lines do not combine as well with some stocks as they may with others. There is no way of predicting accurately how a certain combination will perform. Trial matings and laying house tests are needed to provide such information.

During the past five years, tests have been conducted using purebreds, crossbreds, topcrosses, single-cross-topcrosses, and four-way hybrids. Many of the stocks tested have shown little or no advantage when compared to a good purebred. Some of the combinations have shown increased adult mortality, and at least one showed a surprising amount of broodiness. In many cases the egg size of the experimental stock was improved and the average age at first egg had been reduced.

It is still too early to draw definite conclusions. Some topcrosses have performed as well or better than hybrids. If this performance can be consistently repeated, it may offer a cheaper way of obtaining chickens having hybrid vigor.

Poultry

Forage Crops for Turkeys

TURKEYS grown on a range that supplies good forage require less grain and concentrated feed than those grown in confinement or in an "exercise lot." Experience has shown that from 10 to 20 percent less feed may be required for the period of 10 weeks of age to market time, if good green range is available. This can result in a sizeable cut in the feed bill.

It is a common recommendation that one acre of range be allowed for each 100 turkeys grown. If heavy breed turkeys are placed on range when they are 10 weeks old and are sold at 26 weeks of age, they may be expected to consume about 65 pounds of grain and mash per bird during the range period, or 6500 pounds per 100 birds. When good range reduces food requirements by 10 percent, feed saved per 100 birds would be 650 pounds. If the reduc-

tion reaches 20 percent, one could save 1300 pounds of feed per 100 birds. On this basis, estimating the average cost of the feed saved at only 4 cents per pound, an acre of good range could save the turkey grower feed worth from $26 to $52. This would be considered good annual cash rent for South Dakota farm land, even though allowances are made for seed costs and other minor expenses.

Succulent green pasture is recognized as an excellent source of both fat-soluble and water-soluble vitamins. It also provides appreciable amounts of protein and minerals. When turkeys are kept on land not used for poultry for the previous two years and are moved to a new location on such land regularly, protection against soil-borne diseases and parasites is provided. Crops which provide a dense sod reduce the opportunities for direct contact with the soil, when compared with crops that have little sod-forming ability. Cannibalism and feather-picking are far less troublesome in flocks provided with good range than in flocks grown in confinement or on poor range. Sound use of good range can reduce feed costs and disease hazards in raising turkeys.

Desirable forage crops for turkeys should provide young, new growth during the time the birds are from 10 to 26 weeks of age. Date of hatching determines the period when forage requirements will be greatest. Turkeys hatched April 15 would be ready for the range on or about the first of July. Their greatest use of forage would come during July, August, and September. These are months of high temperatures and low rainfall in South Dakota. Many of our common pasture grasses make but very little new growth during these months.

Several turkey feeding trials have been conducted at the Substation using a variety of crops as forage. Under each heading are given the observations made when the different crops were used for turkeys.

Proso Millet

This was used both for summer forage and for grain to be harvested by the turkeys. When drilled in a solid stand it was fairly good. However, as the season advanced, there was a tendency for birds to clean it up as they went rather than feed over the entire plot. When the proso was allowed to mature before the turkeys were moved in, the birds did a good job of stripping out the seed, but there was considerable loss due to lodging and shattering. Proso does not stand and hold its seed long enough after it ripens to be most useful from this standpoint.

Sorghum and Milo

Several varieties have been tried. They made good growth in spite of low moisture supplies and hot weather. They would seem to be most useful when permitted to mature seed which turkeys can harvest. Some years early frosts stopped growth before the seed had matured. Even with short-stemmed varieties, It was usually necessary to break over some of the stalks in order to get the turkeys to start eat-

ing the seed. With taller growing types, it may be necessary to break down practically all of the sorghum as additional supplies are needed. This can be done by driving down the rows with a truck or tractor.

Rape

This has been one of the most useful forage crops tried so far. The seed is not expensive and it is not hard to get a stand in the more humid areas. Rape may be seeded alone, or combined with a light seeding of oats. It starts quickly and has ability to come back after being heavily pastured. Turkeys like rape and will eat it down to stumps if the supply is not plentiful. Rape does not form a sod. It is an annual crop that can be seeded and pastured the same year. Some turkey growers include a light seeding of rape in their small grain. After the grain has been harvested, the rape will make sufficient growth to provide good fall pasture. Rape will continue to grow in the fall of the year until hard freezes occur.

Sudan Grass

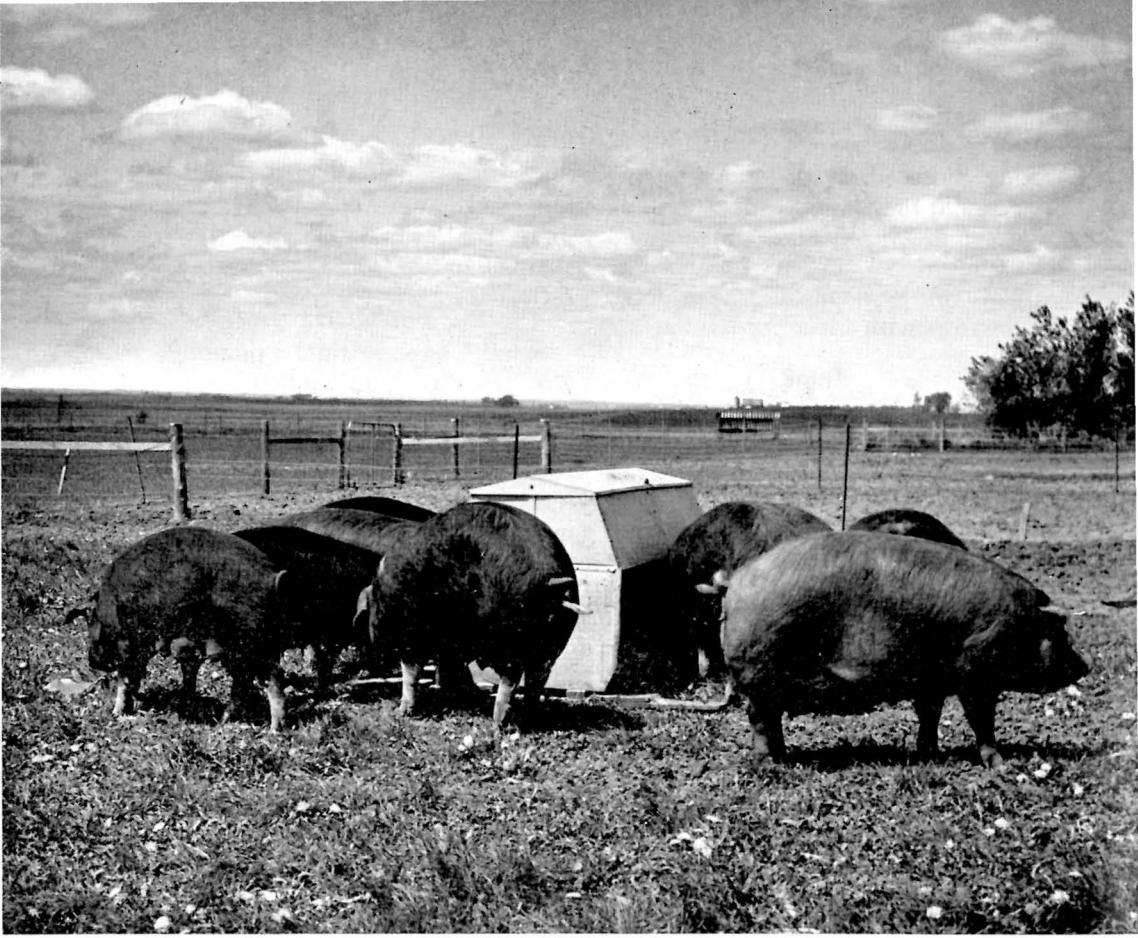
This grass has made a lot of forage during hot weather. Since it is usually seeded late in the growing season, and since it requires high temperatures, it cannot be depended upon to furnish much pasturage until after mid-July. Like some other crops that grow rather tall, it may require some clipping to keep the new growth at a height that can be reached by the turkeys. When Sudan grass was allowed to grow tall, the turkeys did not range over more than a small area close to the shelters and feeders.

Sunflowers

Small, experimental plantings have been tried of a short-stemmed, combine-type of sunflowers. They were planted in rows and were cultivated like corn. Under these conditions sunflowers did not produce much usable forage. A good seed crop was produced and it might have been a feed saver if the turkeys had actually consumed the seed. When the sunflower seed approached maturity, multitudes of wild blackbirds descended upon the plantings and succeeded in harvesting the seed before the turkeys were able to use much of it. Various methods were used to try to discourage the blackbirds. None were successful.

Alfalfa

This perennial crop must be seeded at least a year before it is ready for use. It has furnished an excellent quality of forage and it stands clipping very well. In dry, hot seasons it failed to make a great amount of new, fresh growth during August and September. The cost of seed may be high at times, and it is not always easy to get a good stand. Unless one uses very early hatched turkeys, it should be possible to get a crop of hay from the alfalfa before the turkeys will be ready for the range.



Swine Breeding

Swine Breeding

SWINE BREEDING research has been in progress at the North Central Substation since 1948. Objectives of the work there have been:

1. To maintain a closed Poland China herd of the Minnesota "A" inbred line, ("A" is merely a letter designation assigned to a line of inbred Poland Chinas developed by the Minnesota Agricultural Experiment Station.);

2. To compare performance of the "A" line Poland Chinas with outbred Poland Chinas (mating unrelated Poland China boars and sows;) and

3. To attempt improvement of the "A" line Poland Chinas by combining them in crosses with Missouri Line II Poland Chinas.

Inbreeding, or the maintenance of a closed herd, has been the principal part of swine breeding work at Eureka since its beginning. Inbreeding is not practical for the producer of slaughter hogs since it usually results in decreased vigor as expressed by fertility, growth rate and thriftiness. However, it appears to be valuable as an aid to improvement under certain conditions.

Performance characteristics of swine such as litter size, rate and economy of gain, suckling ability of sows, and general thriftiness are not as simply inherited as are coat color in swine or horns in cattle and sheep. Selection for them on an individual basis is difficult because they are rather easily affected by feeding and management influences and are therefore only "slightly hereditary." Using inbred lines makes possible selection for these "slightly hereditary" characters between groups or families within which there is close relationship. For these characters, selection between families is more accurate than is selection between or among individuals.

Animals from Minnesota's "A" line purchased for the North Central Substation represented an inbred line which had already proved itself. They were inbred to the extent

Table 23. Performance Records of Spring Pigs Farrowed at Eureka, 1948-51

	"A" Line Inbred Poland China				Outbred Poland China Boars Mated to Outbred "A" Line P.C. Sows	Outbred Poland China Boars Mated to "A" Line Sows
	1948	1949	1950	1951	1951	1951
Number sows bred	6	8	12	9	7	2
Number litters	3	7	5	2	6	2
Inbreeding, %						
Sows	21	23	23	35	00	22
Litters	33	34	39	25	00	00
Average number pigs						
Farrowed	5.7	8.0	6.6	8.5	5.5	4.5
56 days	2.3	5.1	2.6	7.0	5.0	4.5
154 days	——	5.0	2.6	7.0	5.0	4.5
Average pig weight						
Farrowed	2.0	1.7	2.7	3.6	2.9	3.9
56 days	37.4	32.2	30.4	38.3	33.0	40.2
154 days	——	141.7	142.2	149.9	160.9	196.0
Average litter weight						
Farrowed	10.0	12.7	17.6	26.8	16.2	35.4
56 days	131.8	165.9	131.7	268.1	173.4	80.3
154 days	.....	708.4	616.3	1049.5	804.3	392

of one generation of full brother-sister mating. This level was raised only slightly during the four seasons the line was continued. Line performance was studied under conditions at the Substation. Boars were used in two rotational crossing programs at Brookings.

It will be seen in Table 23 that performance of the line through four seasons was not outstanding. Reproductive efficiency of the line was such, that of 35 sows and gilts bred through four seasons, only 17, or 49 percent, farrowed litters. These litters averaged 7.2 pigs at birth and 5.0 pigs at weaning—a loss of 32 percent up to weaning time. However, pig weaning weights averaged 34 pounds and 154-day weights averaged 145 pounds in this period. No carcass data was collected on representatives of the line.

During the 1951 season, Poland China litters representing two other kinds of matings were raised. Six of these were purebred litters produced by mating an outbred boar to unrelated outbred sows. Two were litters from inbred sows mated to the same outbred boar that sired the purebred pigs. Comparing performance of litters sired by inbred and outbred boars, it is apparent that outbred boars sired litters averaging fewer pigs per litter but also exhibiting very good livability. Pig weaning weights were comparable, and 154-day weights were appreciably greater among pigs sired by outbred boars.

By 1951 it was apparent that poor breeding efficiency and poor livability, in spite of acceptable growth rate, were making the "A" line difficult to continue. It was decided, therefore, to attempt improvement of the line by crossing it with boars of Poland China Line II, developed at the Missouri Agricultural Experi-

ment Station. For 1952, litters were produced from matings of Line II boars with both inbred and outbred sows raised at the Substation.

Performance is shown in Table 24. As is usually expected from a cross of unrelated stocks, performance was noticeably improved during the 1952 season in reproductive efficiency; livability of pigs and growth rate.

For 1953 litters, ("A" line-Mo. II) pigs were inbred or mated within the herd to attempt fixing the new desirable combinations attained by crossing lines. At the same time comparative performance with (outbred-Mo. II) sows mated to outbred boars was possible. Disease losses knocked out 5 of the 11 litters farrowed in 1953. The usual difficulty in settling sows was also experienced. Therefore, it was felt that the plan of attempted improvement could not be carried out successfully, and the Poland Chinas were dropped from the breeding project at Eureka.

Boars from the Poland China "A" line raised at Eureka were used in a very good performing rotational crossing program at Brookings. In this program, boars representing inbred lines of the Poland China, Hampshire, Duroc and Landrace breeds, were used in successive rotation through two complete cycles of crossbreeding. So far in this system the cross has not "run out" as is sometimes believed will happen. To test this program further, the facilities at Eureka will be utilized in carrying on the rotational crossing. Gilts produced in the last season of two cycles of rotational crossing at Brookings, produced litters sired by inbred Hampshire boars 1954 spring. In successive crosses, boars from Duroc and Yorkshire inbred lines will be used.

Table 24. Performance of Spring Pigs Farrowed at Eureka, 1952 and 1953

	Mo. Line II Boars Mated to		("A" Line Mo. II) Boars Mated	Outbred P.C. Boars Mated
	Outbred Sows	"A" Line Sows	to ("A" Line-Mo. II Sows)	to (Outbred-Mo. II Sows)
	1952	1952	1953	1953
Number sows bred	7	10	11	7
Number litters	5	8	8	3
Inbreeding, %				
Sows	00	25	00	00
Litters	00	00	17	00
Average number pigs				
Farrowed	7.6	6.7	6.9	7.6
56 days	5.0	4.0	1.8	0.33
154 days	5.0	4.1	1.8	0.33
Average pig weight				
Farrowed	3.3	2.6	1.8	3.0
56 days	31.8	32.0	32.2	26.0
154 days	163.1	171.3	150.0	148.0
Average litter weight				
Farrowed	19.1	13.4	14.6	6.0
56 days	159.2	150.6	161.0	26.0
154 days	815.4	807.7	750.0	148.0

A Chat

With the Substation Superintendent

IT WILL BE eight years in March since I took over as superintendent of the North Central Substation. I am happy to report that the Substation has progressed noticeably in the last several years. The reasons are: (1) increase in funds for the Substation, (2) more research, (3) management, and (4) the interest shown by the local people.

I would like to point out here, that this Substation belongs to the people of South Dakota, and particularly to those in and around this area. It is largely up to you farmers, city people, school teachers, councilmen, and county officials to make this Substation a success. How are you responsible for its success? Merely by bringing us your problems, by the interest you take in work being conducted here, the questions regarding our work, and by your Field Day attendance.

With the current world advancement and the increase in our population in the next 25 years, we will have to depend more and more on research and devote ourselves to more scientific farming practices. This cannot be brought about unless we have the cooperation of the people in the state.

I believe the research conducted on this Substation has been very profitable to the farmer. One indication of this is brought out by the attendance and interest in our Field Day. At the first Field Day in 1946, there were 20 farmers present. The attendance has grown each year until at our last Field Day in 1952 there was an attendance of 300 farmers.

For this, I do not want to take full credit, nor does the Experiment Station staff at State College. We are proud to have an open-minded hard working Chamber of Commerce in Eureka. The Chamber has worked hand in hand with me and with State College to make this Substation one of the best.

Mrs. Dittman and the family join me in an expression of appreciation to the Eureka Chamber of Commerce, the local farm and home leaders, and South Dakota State College, for their united effort to make this Substation of service to the north central section of the state.

ALBERT DITTMAN, *Supt.*