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Potatoes in South Dakota

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POTATOES IN SOUTH DAKOTA

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DIGEST

1. Eastern South Dakota is well adapted for the production of potatoes.

2. In general, Early Ohios, Irish Cobblers, Rural New Yorkers, and Burbanks are best adapted to South Dakota conditions.

3. Standardization of varieties is to be recommended.

4. Save the finest tubers for seed. Seven years work shows that they out-yielded culls from 40 to 50 percent.

5. Plant large seed pieces. One-half tuber seed pieces out-yielded one-eighth tuber seed pieces during 7 years by 30 to 40 per cent.

6. There have been only seven potato diseases reported from South Dakota. Only four cause serious trouble when dry rots are not considered.

7. Soaking all seed in formaldehyde, 1 pint to 30 gallons of water for 30 minutes to 1½ hours is always recommended. This will kill scab and Black Scurf or Rhizoctonia in small quantities. If the tubers are heavily infected with these diseases discard and procure clean seed. Where clean seed is not available treat seed with 4 ounces of corrosive sublimate in 30 gallons of water for 30 minutes to 1½ hours. Beware of corrosive sublimate as it is poison.

8. Spray potato vines five or six times with bordeaux mixture to prevent and control such diseases as Rhizoctonia, late blight, early blight, tip burn or hopper burn. Add 4 or 5 pounds of lead arsenate to poison Colorado potato beetles when needed.

9. The best date of seeding as shown by a 5 year experiment is about May 15.

10. Hilling in rows 30 inches each way gives greater yield and facilitates cultivation. Where machine planting is used, drill in rows 42 inches apart and drop the seed every 12 inches. Such drilling has given the best results. Plant about 5 inches deep.

POTATOES IN SOUTH DAKOTA

By

ARTHUR T. EVANS, GEORGE JANSSEN and MATTHEW FOWLDS

During the past few years the potato raising industry has increased rapidly in South Dakota. The eastern part of the state has come to take rank with the best potato growing sections of the United States. The Sioux Valley now produces potatoes which rank in quantity and quality production with the famous Greeley spuds or the well-known Red River Ohios. Sioux Valley spuds should and will undoubtedly rank high on the market in the future.

In 1909, South Dakota raised 50,052 acres of potatoes. These were largely produced east of the Missouri River, with the Black Hills region producing most of the west-of-the-river crop. The average yield for all acres planted was 68.8 bushels per acre. During the next 10 years, or in 1919, the acreage had increased to 58,180 or 16.2 per cent. During the same time the yield per acre had decreased to 49.2 bushels. The total yield for 1909 was 3,441,692 bushels. For 1919 the yield was 2,863,186, a decrease of 578,506 bushels or 12 percent. In short, while we were increasing our acreage 16.2 percent we decreased the yield in bushels 12 percent.

With improved methods of seed treatment and spraying, and proper methods of rotation this loss should have been avoided. Intensive methods would have yielded the potato raisers more than extensive methods. Success on a small acreage leads many growers to believe that the same success may be realized on very much larger acreages. This does not necessarily hold true. The folly of such reasoning comes in the lack of anticipation of the needs of the crop in the way of seed bed preparation, seed treatment, spraying, cultivating, and harvesting. A small acreage well grown may be expected to yield well, whereas, a large acreage poorly attended, where weeds, insect pests and potato diseases are allowed to go unchecked, may be generally expected to result in a poor yield of unmarketable potatoes. For these reasons, and especially because of improper rotation, South Dakota's acreage has not yielded its full capacity. Proper attention of the potato growers in the future to these factors will increase both yield and quality of potatoes.

The value of the potato crop for 1909 was $2,713,412. The total value of the crop for 1919 was $7,157,983, an increase of 263.8 percent in 10 years. This means that while

the acreage was increasing 16.2 percent and the yield was decreasing 12 percent, the total value of the entire crop increased 263.8 percent. According to these figures, which are the latest available, the profits to the farmers were much greater than in 1900 even though the yield per acre was decreased. One must remember that the 1919 statistics represent post war and boom prices. The same figures for 1921, which are not at present available, would show very much different results.

VARIETY TESTS

The South Dakota Experiment Station at Brookings has conducted variety tests on potatoes for a number of years. These varieties were planted at the same time in as comparable ground as possible and the same treatment accorded. For a number of years as many as 25 to 35 varieties of potatoes were tested. This gave a good indication of the varieties which were likely to be successful in South Dakota. Recently all but 10 of these varieties have been dropped. The 10 varieties selected were those whose yield, cooking qualities, and general adaptability seemed to indicate their desirability as marketable potatoes for this state. All the varieties selected are already raised more or less extensively in South Dakota. The varieties as selected are: Bliss Triumph, Irish Cobbler, Early Ohio, White Harvest, Rural New Yorker, Carmen, Burbank, Bugless, Releigh, and King.

Table I shows the yield of all varieties of potatoes at the experiment station at Brookings. This includes practically every variety raised in the state.

Table II gives the annual and average yield for the variety tests at Brookings for the 10 most popular varieties as long as they have been raised. Similar data are given in Table III for Cottonwood; in Table IV for Eureka; and in Table V for Highmore.

The data in Table II are the results of potato work at the Brookings station since 1913. In 1920 there were no yields, as wet weather destroyed the crop. Out of the 10 varieties listed it will be noted that only one, Bliss Triumph, fell below 120 bushels for an average of seven or more years. The King, which was included in the tests in 1921 for the first time, yielded 8 bushels more than its nearest competitor, the Early Ohio. The Bugless leads with an average of 161.7 bushels for seven years. This yield is due largely to its enormous yield in 1915. The yield of the other varieties place them in the following order: Carman, Burbank, Raleigh, Irish Cobbler, Rural New Yorker, Early Ohio. Yield, however, does

not always prove and indicate the best potatoes to raise. Percentage of marketable potatoes, cooking qualities, and demand on the market are very important, in fact the most important factors. It is significant to note that although the Early Ohio is rather low in yield as compared with others, approximately 50 percent of the potatoes grown for market in South Dakota are of this variety. Its consistent good yield of marketable potatoes, its good cooking qualities, and its desirable size are all big factors in making it a prime favorite. Large oversize potatoes of the Bugless type are undesirable in the market. This is due to the demand for a potato the right size for one serving without cutting. Hotels and restaurants insist upon this. Then, too, large potatoes have a tendency to be coarse.

Table V for the Highmore substation shows the Irish Cobbler as the leading variety. The Frederick which has been raised for 3 years yields well with an average of 102.6 bushels. This potato was tried at Brookings in 1921 but produced only 30.5 bushels per acre. It is also interesting to note that the King, which was raised at Highmore for the first time, yielded 193.3 bushels. This potato also proved to be the highest yielder in 1921 at Brookings. The White Harvest is next to the Irish Cobbler as a yielder at Highmore when only those varieties raised for seven or more years are considered. The Early Ohio follows closely behind the White Harvest. The White Harvest has proven a very poor cooking potato so should not be considered as a potato worthy of much consideration, when better cooking and yielding potatoes are available.

TABLE I.

ANNUAL AND AVERAGE YIELDS IN POTATO VARIETY TEST AT BROOKINGS, 1913-1919 INCLUSIVE.

Variety	S. D. No.	Yield in Bushels per Acre							Averages	
		1913	1914	1915	1916	1917	1918	1919	6 yrs.	7 yrs.
Bugless	876		212	382	88.1	221.7	67.5	110.	180.2	
Late Rose	16	131.3	222	316	104.5	225.8	115.	66.6	174.9	168.7
Raleigh	345	156.5	240	262	106.5	162.5	81.7	61.6	152.4	152.9
Irish Cobbler	874		206	284	91.7	155.8	96.7	28.2	152.1	
White Ohio	880		232	240	107.1	213.3	47.5	23.4	143.7	
Eureka	884		208	220	115.5	201.7	45.8	15.0	134.3	
Golden Russet	334	127.8	210	258	69.0	215.8	108.3	46.6	151.3	147.9
Burbank	347	158.7	200	228	89.2	240.	141.7	55.2	159.0	158.9
Carmen No. 3	279	127.2	198	206	104.5	204.2	66.7	98.2	146.3	143.5
Astonisher	883		222	168	108.0	222.5	101.7	20.0	140.3	
Pearl	890		196	224	64.3	200.	58.3	11.6	125.7	
Blue Victor	873		210	204	64.5	181.7	71.7	60.0	131.9	
Surprise	885		202	150	114.2	205.8	61.7	15.0	124.8	
Quick Lunch	881		154	204	96.5	243.3	133.3	40.0	145.2	
New Queen	882		226	158	70.2	167.5	85.	18.2	120.8	
Early Ohio	280	166.0	175	149	126.2	154.9	106.7	56.7	128.1	133.5
Rural New Yorker No. 2	228	145.7	216	140	91.6	171.7	105.8	100.0	137.5	138.7
White Harvest	875		203	144	98.8	179.2	120.	63.4	134.7	
Livingstone Banner	879		124	154	78.6	112.5	88.3	41.6	99.8	
Acme	886		200	64	90.5	116.7	90.0	41.6	100.4	
Early Rose	878		120	106	116.7	142.5	88.3	43.4	102.8	
Bliss Triumph	877		144	70	100.0	121.7	60.8	13.3	84.9	
Six Weeks	253	124.2	152	89	50.0	86.7	54.2	26.6	76.4	83.2
Lawrence	554			204	138.1	171.7	122.5	35.0		
King							91.7	63.4		
Early Petosky						210	83.3	13.2		
Mortgage Lifter						135.	83.3	2.6		
Norwegian White						171.7	125.			
Dodson's Early White Rose.							64.2	48.2		

TABLE II.

YIELD PER ACRE OF THE LEADING VARIETIES AT THE BROOKINGS STATION.

Variety	1913	1914	1915	1916	1917	1918	1919	1920	1921	Av.
Bugless		212.0	382.0	88.1	221.7	67.5	110.0	Failure	50.8	161.7
Carman No. 3	127.2	198.0	206.0	104.5	204.2	66.7	98.2	Failure	48.3	156.6
Burbank	158.7	200.0	228.0	89.2	240.0	141.7	55.2	Failure	22.2	143.2
Raleigh	156.5	240.0	262.0	106.5	162.5	81.7	61.6	Failure	65.0	141.9
Irish Cobbler		206.0	284.0	91.7	155.8	96.7	28.2	Failure	74.9	133.9
Rural New Yorker No. 2	145.7	216.0	140.0	91.6	171.7	105.5	100.0	Failure	62.5	129.1
Early Ohio	166.0	175.0	149.0	126.2	155.0	106.7	56.7	Failure	83.3	127.2
White Harvest		203.0	144.0	98.8	179.2	120.0	63.4	Failure	37.5	120.8
King								Failure	91.2	91.2
Bliss Triumph		144.0	70.0	100.0	121.7	60.8	13.3	Failure	42.5	78.0

TABLE III.

YIELD PER ACRE OF THE LEADING VARIETIES AT THE COTTONWOOD SUBSTATION

Variety	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	Av.
White Harvest				79.2	65.2	7.9	70.0	Failure	Failure	Failure	55.7
Acme				61.2	74.5	12.7	74.4	Failure	Failure	Failure	55.7
Early Ohios	40.5	8.0	20.6	22.5	80.2	13.1	110.4	Failure	21.1	Failure	49.4
Burbank						13.8	90.9	Failure	Failure	Failure	52.3
Six Weeks				40.4	70.2	17.2	69.9	Failure	Failure	Failure	49.4
Livingston Banner						7.1	114.2	Failure	18.3	Failure	46.5
Eureka				14.2	66.2	9.5	82.7	Failure		Failure	43.1
Irish Cobbler				39.2	53.5	9.2	63.7	Failure		Failure	41.4
Surprise				5.8	75.8	11.7	64.6	Failure		Failure	39.5
Bugless				55.0	30.6	5.0	64.2	Failure		Failure	38.7
Golden Russet				34.1	36.6	3.3	73.6	Failure	40.8	Failure	37.7
New Queen				20.8	56.3	8.3	88.6	Failure	13.3	Failure	37.5
Rural New Yorker No. 2						10.9	69.1	Failure	27.5	Failure	35.8
Astonisher						9.4	61.7	Failure		Failure	35.5
Raleigh						8.5	62.1	Failure		Failure	35.3
White Ohios				33.3	74.5	13.3	46.9	Failure	7.5	Failure	35.1
Blue Victor				65.0	46.8	8.1	38.8	Failure	12.5	Failure	34.2
Pearl				41.7	38.7	8.6	31.0	Failure		Failure	30.0
Quick Lunch				28.8	43.1	6.5	60.2	Failure	9.2	Failure	29.6
Carman No. 3		1.4	8.8	26.6		9.9	82.7	Failure		Failure	25.9
Late Rose	8.9	1.9	11.7	3.3	65.1			Failure	35.8	Failure	21.1

Table III shows all of the varieties of potatoes which have been raised at the Cottonwood substation. On account of the more unfavorable climatic conditions the yields in this part of the state are materially reduced. The best yielding variety is White Harvest, followed closely by Acme, Burbank, and Early Ohio. The latter two are much to be desired over the White Harvest on account of its poor cooking qualities. It is to be noted that the Early Ohio is figured on the basis of eight years which materially reduces the average for this variety, due to the very unfavorable season in 1913.

TABLE IV.

YIELD PER ACRE OF THE LEADING VARIETIES AT THE EUREKA SUBSTATION.

Variety	S. D. No.	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	Av. 1915–1921
White Ohio	880				181.5	181.0	94.1	342.0	83.4	100.8	98.3	154.4
Irish Cobbler	874				268.4	245.6	112.1	40.9	102.1	105.0	105.8	139.9
Early Ohios	15	65.5	76.9	85.3	215.0	175.5	94.2	48.3	146.7	108.0	159.1	135.3
Raleigh	345				296.6	130.0	89.3	25.0	56.3	163.3	100.8	123.0
Bugless	876				362.5	125.3	93.7	25.0	56.3	122.8	72.5	122.6
Eureka	884				221.7	176.0	82.9	38.0	75.0	102.9	74.9	110.2
Livingston Banner	879				98.4	161.5	127.1	34.2	110.8	112.8	73.3	102.6
Surprise	885				148.0	159.0	74.2	27.5	67.1	115.8	97.5	98.4
Astonisher	883				185.0	136.0	98.3	34.2	61.7	108.3	65.0	98.3
Acme	886				66.7	131.7	75.0	38.4	120.0	100.0	154.2	98.0
Blue Victor	873				218.4	145.0	97.5	28.4	59.1	59.1	70.0	96.8
Golden Russet	344				223.0	129.0	79.6	25.0	57.5	55.8	60.8	90.1
New Queen	882				103.4	138.4	84.6	30.0	48.8	108.3	99.2	87.5
Rural New Yorker No. 2	228				125.4	151.0	74.6	34.2	37.5	87.5	95.8	86.6
Late Rose	16	[1]12.3	45.6	78.8							78.9	78.9
Pearl	890				158.0	94.0	79.6	21.7	52.5	62.5	69.1	76.8
Quick Lunch	881				126.8	91.0	78.8	29.2	45.0	73.6	74.2	74.1
Burbank	347				132.5	122.0	80.9	31.7	34.6	42.5	53.3	71.1
Six Weeks	253				40.0	108.0	82.1	26.7	96.3	80.0	63.3	70.9
Carman No. 3	279		58.2	74.1	138.5	123.0	63.3	31.7	32.1	34.2	32.5	65.0
White Harvest	875				116.5	87.5	87.5	26.7	21.3	42.5	61.6	63.4

Table IV shows the results of six years potato raising at the Eureka substation. The results obtained at this station are very encouraging for potato raisers. The White Ohio, Irish Cobbler, and Early Ohio have proven the best yielders. Since these potatoes are of good quality they are recommended to the growers in that region. A proper rotation, such as that recommended on the cultural methods at the Eureka substation, is probably in a large degree responsible for the good results obtained.

TABLE V.

YIELD PER ACRE OF THE LEADING VARIETIES AT THE HIGHMORE SUBSTATION.

Variety	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	Av.
King										193.3	193.3
Irish Cobbler ...			134.3	215.3	94.9	91.2	63.3	125.4	31.4	177.7	116.68
Frederich								85.	134.6	86.6	102.6
White Harvest..			86.4	297.3	94.7	88.8	78.3	56.0	24.1	94.4	102.5
Early Ohio	51.6	119.3	107.2	151.4	77.3	88.3	19.8	50.0	26.9	170.2	94.4
Bugless			106.2	230.6	66.9	84.4	61.6	13.3	17.1	136.6	89.58
Carman No. 3...	69.8	29.8	69.0	188.6	161.8	77.7	43.3	12.1			81.5
Rural New Yorker No. 2 ...			104.9	122.0	138.9	67.5	30.8	0.0	7.0	105.8	72.1
Bliss Triumph...			85.5	113.2	58.2	53.3	45.8	12.1	16.9	122.1	63.4
Raleigh			49.8		123.6	104.4	90.8	17.5	26.9	20.8	62.2
Burbank			32.0	115.2	131.3	84.5	25.0	26.6	8.7	45.0	54.93

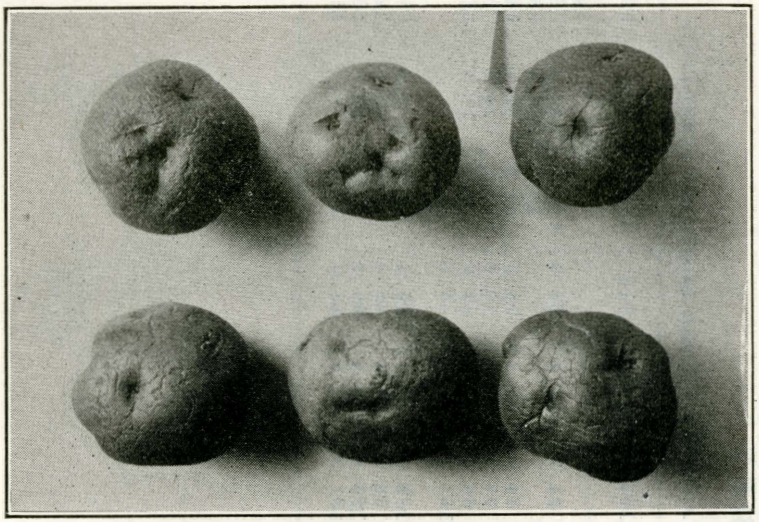

Figure 1. Bliss Triumph, S. D. 877.*

Triumph. Synonyms, **Bliss Triumph, Red Bliss, Stray Beauty, Red Six Weeks, Early Hunt.** Originated in Connecticut; claimed to be a seedling of Peerless crossed with a seedling of Early Rose. Introduced by B. K. Bliss & Sons in 1878.

Description.—Season early, matures about 10 days earlier than Early Rose and is more productive. Vines erect; foliage dark green. Tubers medium size, round, uniform. Vines erect; foliage dark green. Tubers medium size, round, uniform in shape; eyes slightly depressed; skin light red; flesh fine grained.

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*Stuart, Wm. Group Classification and Varietal Descriptions of some American Potatoes. In U. S. Dept. Agr. Bul., No. 176. 1918.

Figure 2. Carman No. 3, S. D. 279.

Carman No. 3. Originated by E. S. Carman in 1888; claimed to be a seedling of a seedling. Introduced in 1895 by J. M. Thorburn & Co., who say of it: "The Carman No. 3, which we now offer for the first time, is, like the Carman No. 1, a seedling from seedlings raised through several generations by the experienced originator whose name they bear."

Description.—Season late. Resembles the Carman No. 1 except that tubers are a little more elongated. They grow compactly in the hill and the plants resist drought well. Vines strong and vigorous; foliage heavy and dark green; tubers large; eyes very shallow and but few in number; skin and flesh of extreme whiteness.

Figure 3. Burbank, S. D. 347.

Burbank's Seedling. Synonym, **Burbank.** Originated by Luther Burbank in 1873; claimed to be a seedling of Early Rose. Introduced by J. J. H. Gregory in 1876.

Description.—Season medium late. Gregory says, "I send out this season for the first time the new potato, Burbank's Seedling. This, like the Early Ohio, is a seedling of Early Rose, but is of Massachusetts origin. Ranks between the very early and the very late varieties. Has but few eyes, which are sunk but little below the surface; unlike its parent it is white skinned. In quality it is firm, fine grained, of excellent flavor either boiled or baked, dry, and floury."

Note.—It is well known that Burbank's Seedling possesses a relatively large number of eyes.

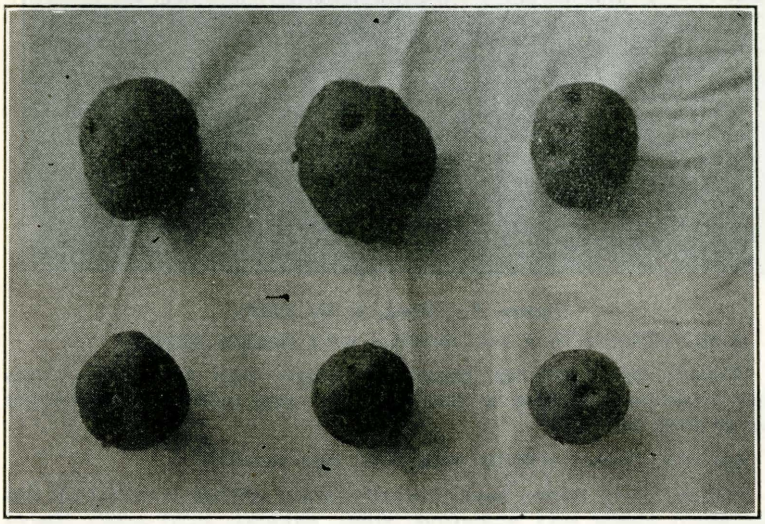

Figure 4. White Harvest, S. D. 875.

White Harvest S. D. 875, is an early, white potato, belonging to the Green Mountain group. The vines are large, strong, and well branched. The flowers are white and abundant. The tubers are round-flattened, with shading to russet near the seed end. Its cooking qualities are poor.

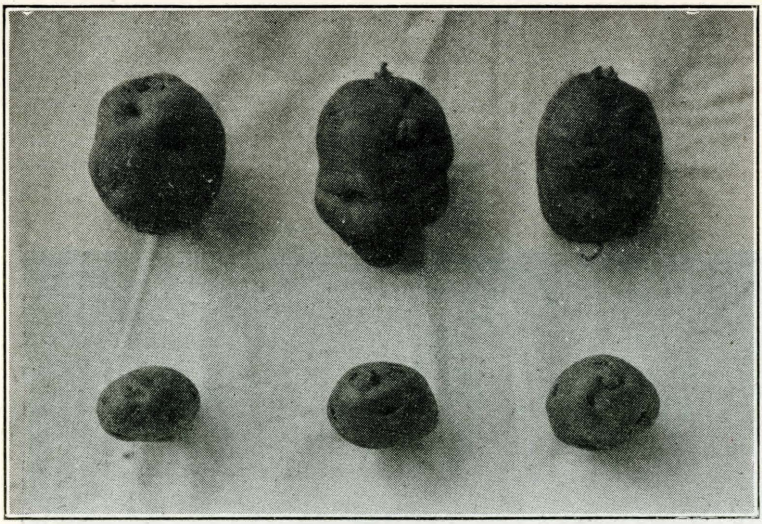

Figure 5. King, S. D. 1257.

King.—Similar to if not identical with Maggie Murphy.

Tubers: Broad oblong, flattened, blocky, with blunt ends; eyes rather numerous, medium to deep, pinkish; skin reddish, with deepest color at seed end.

Sprouts: Tinged slightly with pink, tips carmine.

Plants: Very large, bushy, mostly erect, giving row broad flat appearance; stems very numerous, stout, angular, light green tinged with purple; leaves medium dark green; upper side of leaf and leaflet petioles tinged purple; flowers white and nearly always drop before opening.

Raleigh S. D. 345.

Raleigh S. D. 345, is a late maturing variety of the Rural Group. It was originated by E. S. Carman and is said to be a seedling of Rural New Yorker No. 2. The vines are medium to large in size with primary stem upright, long jointed, and sparsely covered with foliage. The stems are slightly streaked with dark purple. The leaves are small, dark green, crumpled and leathery to the touch. Its flowers are fairly abundant and of fair size; the central portion of the corolla being a deep violet purple. The tubers are round-flattened to broadly roundish. The eyes are few and very shallow. The skin is creamy white and occasionally netted. The sprouts are blue, short and have base enlarged. Its cooking and keeping qualities are excellent. The variety yields well in the eastern part of the state, but like other late varieties is not suited to the western section.

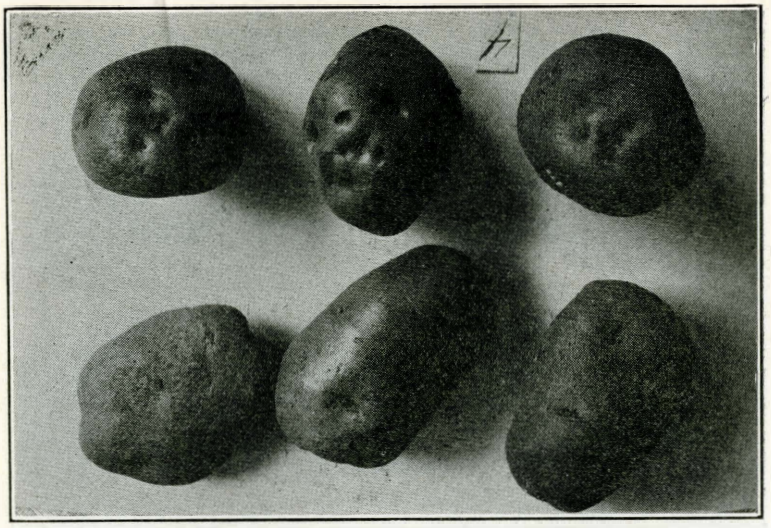

Figure 6. Bugless S. D. 876.

Bugless, S. D. 876, is a late maturing variety belonging to the Rural group. It was introduced into South Dakota by the Gurney Seed Company of Yankton. The vines are heavy with medium sized, heavy, dark green leaves, which feel leathery. The eyes are comparatively few and shallow. The tubers are large, white and firm. Its cooking and keeping qualities are good. It has also proved an excellent yielder when the seasons are favorable to late maturing varieties.

Figure 7. Early Ohio S. D. 280 or S. D. 15.

Originated by Alfred Reese in 1871; claimed to be a seedling of Early Rose. Introduced by J. J. H. Gregory in 1875.

Description.—Grown side by side with the Early Rose, it proved several days earlier and its yield a third greater. While similar to the Early Rose in color, it is quite distinct in shape, being round oblong instead of oval-oblong, and can be easily distinguished; eyes about as numerous as those of the parent, brows rather more prominent; on the largest specimens the clusters of eyes at the seed end are located slightly to one side of the longer axis.

Figure 8. Irish Cobbler S. D. 874.

Origin not known; claimed by some leading seedsmen to have been first grown by an Irish shoemaker of Marblehead, Mass.

Description.—Season extra early. Gregory says, "Similar or identical with Eureka." Tubers nearly round, large; eyes good; skin russet, finely netted; flesh white.

Note.—In the writer's opinion the Irish Cobbler is simply a strain of the Early Eureka, and at the present time the two are so hopelessly mixed up as to be indistinguishable. There are some growers and seedsmen, however, who seem to believe that the two varieties are distinct entities.

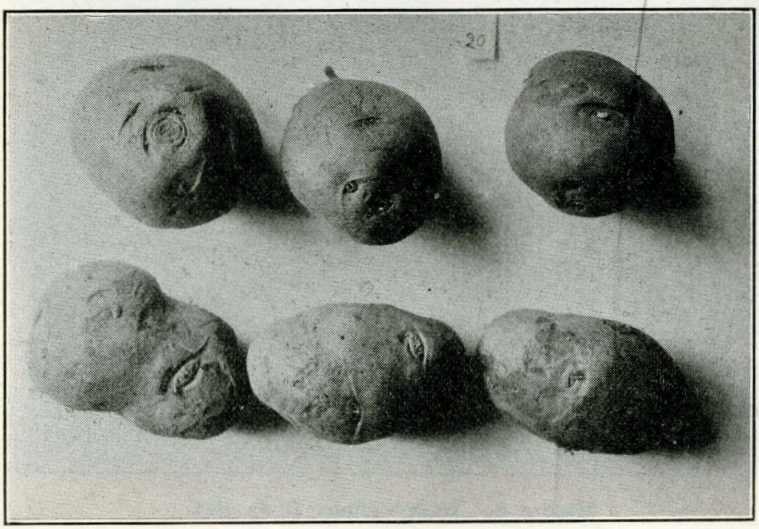

Figure 9. Rural New Yorker No. 2, S. D. 228.

Originated by E. S. Carman; claimed to be a seedling of seedlings raised through several generations. Introduced to Rural New Yorker subscribers in a very limited way in 1888.

Description.—Season medium late. Vines thrifty and strong. Tubers oblong, inclined to round or round-oval, rather flattened; eyes few, shallow; skin pure white, netted; flesh white.

SELECTION OF SEED POTATOES

The necessity of careful seed selection in potatoes cannot be over emphasized. Many who are very careful with cereal grain selection may pay little or no attention to the importance of proper potato tuber selection.

The Experiment Station has run a series of experiments for a number of years testing the value of proper selection with Burbank potatoes. Three methods have been used. (1) hill selection; (2) tuber selection; (3) bulk seed.

Hill Selection: Under this head only the choicest high yielding hills are used. This necessitates the digging by hand of that part of the field which is to be used for the selection. Each hill is dug and its progeny placed in a pile near it. After all the hills are dug the selection is made on the basis of high yield and uniformity of tubers. A hill with a considerable number of small tubers is never taken. The selections are sacked separately as individual hills. The highest of these high yielding hills are planted the following year in definite rows, so that the seed becomes pedigreed. That seed which is not used in the pedigree work is bulked and is planted into our high yielding plat.

Selected Tubers: From other plats we pick all the choice tubers, regardless of whether or not the hill is high yielding. This gives us choice seed for the following year. This choice seed is planted into our select tuber plats the following season.

Bulk Tubers: From some plats we harvest and sack the crop without any sorting whatsoever. When we are ready to plant the following season the amount of seed desired is weighed out and all tubers are cut without regard to size. Of course, allowance is made for potatoes which are not fit for seed because of rot, etc., but size is not considered. These are planted on the bulk seed plats.

In this selection work of high yielding hills, select tubers, and bulk seed, not enough data are available for a table, but the work indicates that hill selection will out-yield select tuber planting and the select tuber planting will out-yield the bulk plantings. Then, too, the quality of the tubers is much better from the selected hill stock.

Good seed is as necessary for a good yield and a good quality of potatoes as in any other crop. The old belief that small potatoes planted would give good results is as erroneous as the belief that a scrub sire or a nubbin of corn will give as good results as select stock.

These facts are better explained in a discussion of the problem in connection with data obtained from some experimental work.

KIND OF SEED TO PLANT

Data are available for the 8 years from 1914 to 1921, inclusive, on work with planting of culls and large potatoes of Early Ohios and Carman No. 3. In the beginning the culls and large potatoes came from the same stock. Thereafter the culls were selected out of cull rows and the large potatoes out of large potato rows. The weight of the cull seed pieces equaled in weight the seed pieces from the large potatoes. The figures given are figured in pounds and in bushels on the basis of a 10 hill row.

TABLE VI.

	1914	1915	1916	1917	1918	1919	1920	1921	Average In lbs.	Average In Bu.
Early Ohio										
Culls	6.7	2.2	4.1	4.0	4.0	1.5	.4	4.5	3.4	40.8
Large	9.4	3.5	7.2	7.4	5.6	6.7	.3	8.7	6.1	73.2
Carman No. 3										
Culls	11.7	3.5	2.3	3.5	1.2	.6	.3	3.0	3.3	39.6
Large	12.7	7.5	3.7	4.8	1.1	8.6	3.5	10.4	6.5	78.0

The consistency with which the large potatoes have outyielded the culls is striking. In the Early Ohios the yield is 32.4 bushels greater, or 44.2 percent; in the Carman No. 3 it is 38.4 bushels greater, or 49.2 percent. It is often argued that the planting of small potatoes is as profitable as planting large ones. This experiment does not bear out such a statement especially if the same variety is maintained on the farm and cull selection is a continuous practice.

For the same number of years, i. e., 1914 to 1921, inclusive, an experiment has been conducted dealing with the planting of large, medium, and small seed pieces. The different size seed pieces were all cut from the same potato. A large potato was selected. It was cut in half, one piece forming the large seed piece. The other half was split again so the medium seed piece really became one-fourth of the potato. The small seed piece was obtained by cutting one-fourth of the tuber in two, i. e., it was one-eighth of the tuber. These various pieces were planted under comparable conditions with the following results.

TABLE VII.

	1914	1915	1916	1917	1918	1919	1920	1921	Average in Lbs.	Average in Bus.
Early Ohio										
Large	16.8	12.5	9.9	13.9	14.7	15.5	3.7	10.8	12.2	146.4
Medium ..	15.1	10.2	7.3	12.4	11.5	10.7	3.7	9.5	10.0	120.0
Small	7.5	4.5	4.8	8.7	7.5	5.5	2.2	8.4	6.1	73.2
Carman No. 3										
Large	17.8	7.2	9.1	22.5	9.7	17.8	8.2	12.4	13.1	157.2
Medium ..	13.0	7.8	6.6	13.8	9.8	13.8	6.0	12.1	10.4	124.8
Small	9.5	4.5	3.4	14.2	3.0	8.8	2.5	8.7	6.8	81.6

Here again the results are strikingly consistent. In both the case of the Early Ohio and the Carman No. 3 the results coincide perfectly in favor of the large seed piece over all others and the medium seed piece over the smaller.

In the case of the Early Ohio the large seed piece out-yielded the medium size seed piece by 19.8 percent while the medium size seed piece out-yielded the smallest by 39 percent. In the instance of the Carman No. 3 the largest seed piece out-yielded the medium by 20.6 percent while the medium seed pieces out-yielded the smaller by 34.7 percent. The results obtained in the case of each variety are rather consistent although probably not significant. Certainly the results of this experiment recommend in a most emphatic way the planting of large seed pieces. A potato plant is probably like a young animal—rather dependent upon a good start. A large amount of food in a seed piece probably means a more vigorous shoot which will grow faster, resist disease more successfully, and mature somewhat earlier. These are data which cannot well go unheeded.

These data recall to mind the large yields obtained by European growers, whose practice it is to plant whole potatoes. They claim, for such a practice, a lower rate of infection from diseases which are in the soil, and higher yields. Where such a method is practiced it is necessary to thin down to two or three vigorous sprouts. This is the objectionable feature in this country on account of high priced labor. The removal of some eyes before planting is sometimes resorted to, but it has the disadvantage of not avoiding diseases which may be present in the soil. Vigorous sprouts may account for the large yields in a measure. Many of the clons used for seed in experimental work at the South Dakota Experiment Station are one-half of a potato secured by splitting a tuber from stem to blossom end. Two pieces are planted in a hill to insure a stand. This is recommended to the attention of all growers.

Another common practice in European countries is that of sun sprouting the tubers before planting. When exposed to good light but not direct sunlight, the potatoes develop thick green sprouts very different from the slender etiolated shoots which develop in a dark place such as a cellar. When these sprouts are from one-half to one inch in length, the potatoes are planted. The sprouting is timed so as to coincide with the time of planting. Such tubers grow rapidly and will appear much sooner above ground. For small garden lots or for early new potatoes such a practice is feasible, but labor in this country would be too high to use it on extensive acreages.

POTATO DISEASES

The diseases which cause a loss in production of potatoes are of two types; (1) those which are present on the potato clons before planting, and (2) those which attack the vines and tubers during their growth and maturity. The diseases which occur under either of these types can be very destructive. They may destroy the vines so that no tubers are formed or they may attack the tubers directly causing diseased and deformed potatoes. Either point of attack may result in unmarketable tubers.

Improvements on the methods of treatment of seed and also of methods of spraying the vines has helped materially to reduce the losses from disease. By proper seed treatment and systematic spraying during the growing season a greater part of the diseases causing the losses to potato growers may be eliminated or controlled.

The South Dakota potato industry has developed sufficiently that it is not necessary to advise the growers concerning the merits of proper seed selection and seed treatment. Poor seed infected with disease or selected from "run out" stock is directly responsible for failure of many seed pieces to grow. This results in poor stands and poor stands mean low production. The wise potato grower selects his seed for the following year from his best field and stores it carefully in bins which are clean so that the following year's crop is assured. This seed must be free from injuries.

A discussion of all the potato diseases known to occur in South Dakota, together with the methods of recognition, and treatment, prevalence, and any other points of interest concerning it, is given below. A few diseases of minor importance, as well as some which have not been found in South Dakota as yet, are also given. It is very important that potato diseases which do not occur here be recognized by the growers, should they ever appear, in order that proper quarantine or steps to eliminate them may be taken if necessary.

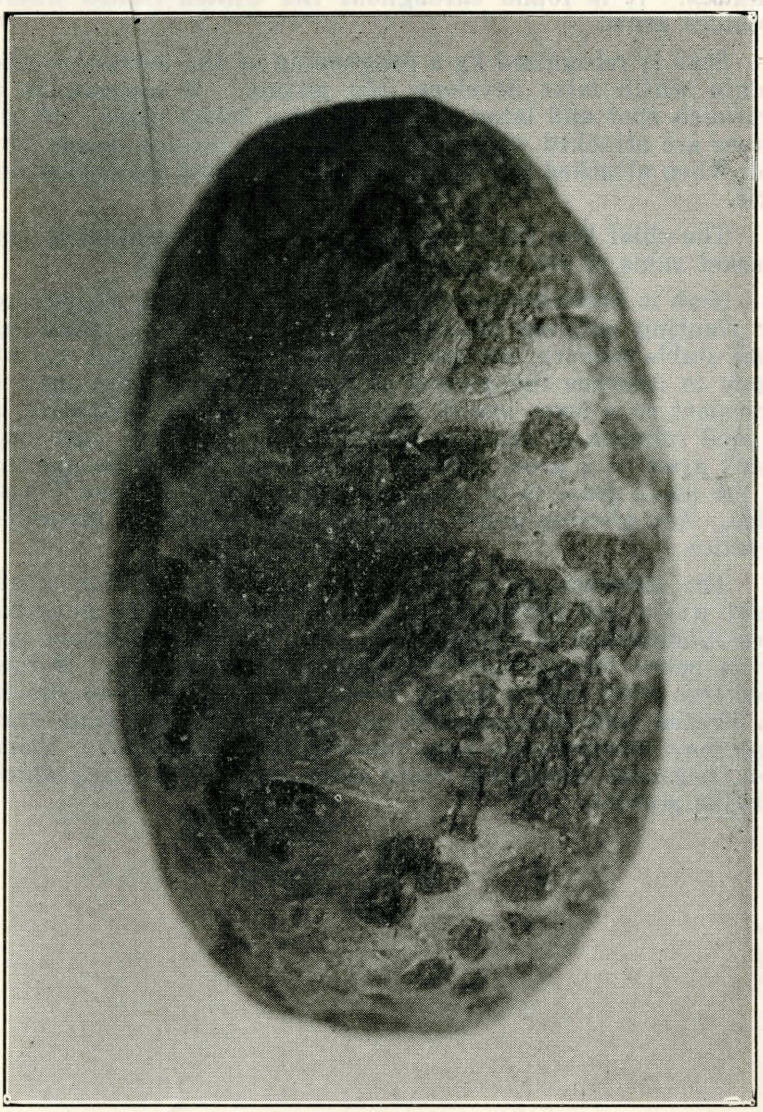

Figure 10. Scab.

Common Scab. (Actinomyces scabies (Thaxt) Guss.)

Scab is one of the commonest and best known of potato diseases. It is found throughout the United States where potatoes grow.

Scab is recognized by a roughening of the surface of the potato which later develops into pitting. It appears as a brownish spot and later develops into a corky layer. If potatoes are attacked when young they may become deeply pitted; when attacked late the corky incrustations are characteristic.

The chief loss from scab comes from depreciation in the market value of the tubers. The yield is also cut.

Scab is prevalent in alkali soils or it may be introduced by planting potatoes which are infected. Heavy manuring with stable manure, the use of potash, soda and lime, are all likely to increase the growth of the fungus. Where scab is prevalent on a farm, one of the best methods of combating is a good rotation of three or more years. Potatoes, corn and small grain is a good rotation. A legume should be planted in the small grain to be plowed under early in August if possible. The plowing under of green crops is a very favorable practice.

The presence of scab on seed potatoes calls for treatment which will eliminate it. Either formaldehyde or corrosive sublimate is effective in this case. Proper directions are given below for the use of these two disinfectants. Potato seed free from scab is highly desirable but no potatoes should be planted without treatment, no matter how free from scab they may appear, as such examination is not conclusive. Then, too, treatment eliminates many other external diseases which may be present.

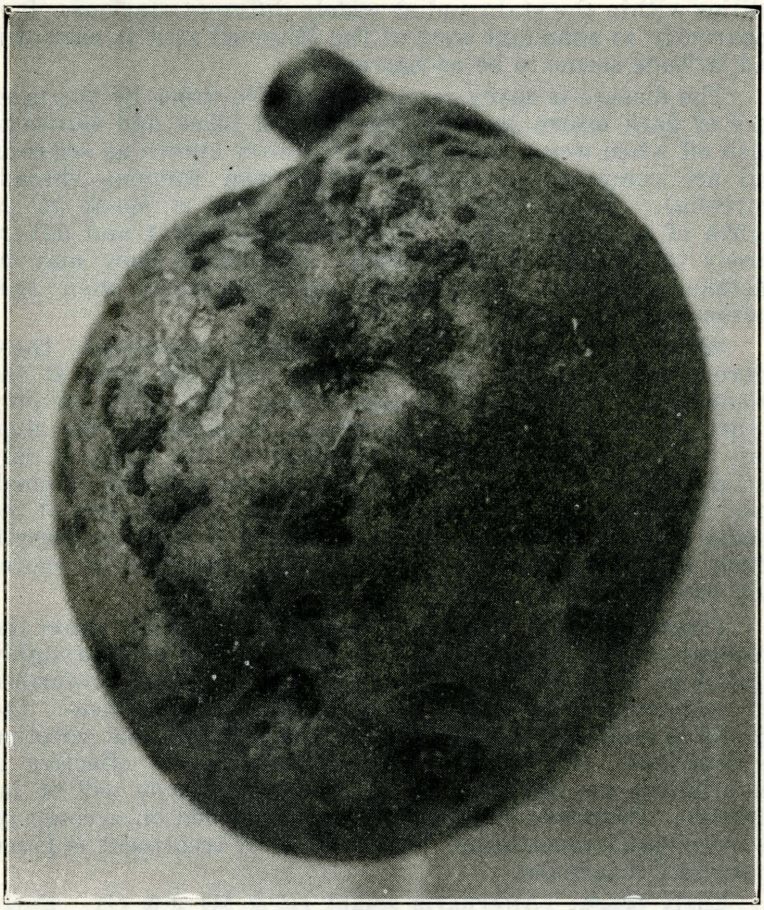

Figure 11. Rhizoctonia. Black Scurf.

Black Scurf or Rhizoctonia. (Corticium vagum B and C).

This disease is prevalent in nearly every potato growing region of the United States. It is especially prevalent in South Dakota. Special investigations carried on by the senior author has revealed its presence in one hundred or more localities within the state and at widely different stations. It is apparently as abundant west of the Missouri as it is east of it and latitude seems to be no barrier.

The disease is easily recognized on the tuber by the presence of dark brown spots which turn jet black and refuse to wash off when wet. These spots are better known as sclerotia and are composed of densely interwoven fungous threads (mycelia). These black bodies vary from a speck to an eighth of an inch in size. They are always flat and adhere closely to the skin of the tubers. Oftentimes they may be mistaken for dirt, but washing quickly reveals their true character.

When potatoes are planted without treatment, these sclerotia develop. An attack is made upon the stem at the ground line. Here the plant turns black. The whole, or only a part, of the stem may be encircled. If encircled, the stem may die. If only one side is attacked or the plant is only partially girdled, the stems may bear aerial potatoes of small size. Oftentimes the blackened area at the ground level of the potato may be more or less covered with a fungous growth which will bear spores. However, this production of spores may be omitted.

Potatoes which are to be planted and which show the presence of the sclerotia of Rhizoctonia should be thoroughly treated or not used. Disease free seed is always preferable but ordinarily treatment is very successful. Where the ground is contaminated it is always imperative that rotation be practiced. Treatment with formaldehyde is effective if the sclerotia are small; if large the formaldehyde will be ineffective. Corrosive sublimate is recommended on account of its more rapid penetration. The method of treatment is given under seed treatment.

Early Blight (Alternaria solani (E & M) J & G). Early Blight is one of the serious potato diseases. It occurs throughout the United States and elsewhere where potatoes are grown.

This disease appears early on the leaves, usually about the middle of June. It is readily recognized by the irregular roundish brown spots. Close examination of these brown areas will reveal concentric circles in the forms of ridges. This is always typical for this disease. By slow development

the brown spots may coalesce in two weeks to a month's time, killing a large part or all of the leaf. This destruction of green tissue curtails the manufacture of food and so decreases the yield. The loss will be proportionate to the severity of the disease. Often Early Blight is confused with Tipburn. The brown dead areas in the body of the leaf, with concentric markings, should identify Early Blight at once. Where all the leaves are dead one must base his diagnosis on the concentric markings.

Since this is a disease of dry areas, South Dakota may be expected to always have a full share of it. Careful spraying, however, readily holds the disease in check.

Tipburn. The name of this trouble is quite enough to distinguish. It occurs when the weather is hot and winds cause high loss of moisture. The tips of the leaves begin to dry. As further drying occurs they begin to roll, always with the upper side of the leaf innermost. The appearance of tipburn at the edge of the leaf and lack of dead brown areas with concentric markings in the body of the leaf, distinguish it rather easily from Early Blight.

Experimentation has proven that the potato leaf hopper is the factor in the production of tipburn or hopper-burn in potatoes. Extractions of the bodies of hoppers injected into the leaves of potatoes gave injury similar to if not identical with tipburn. The insects evidently contain some substance toxic to the potato which is transferred to it when the hopper injures the leaf. Spraying with bordeaux may lessen the loss. Bordeaux mixture does not prevent tipburn by its action on the leaf but by its action on the insect.*

*Fenton, F. A. and Ressler, I. L. 1922. Artificial Production of Tipburn. Science, Vol. 55, No. 1411, pp. 54.

Figure 12. Burbank S. D. 347.

Wilt caused by Fusarium oxysporum. This disease may be detected by cutting a thin slice from the stem end of the tuber. Here it shows a browning of the vascular system.

Wilt. (Fusarium oxysporum Schl). This disease makes its appearance in the field when the potatoes are about a foot high. The plant assumes an unhealthy appearance, the leaves roll and the top droops. The roots when pulled up may disclose the presence of a white or pink mold on their surface. When cut across they show a pronounced brown discoloration. This discoloration continues into the tubers where one may note it as a brown discoloration in the vascular system by making a thin slice across the stem end.

The presence of this disease in a field is serious. The newly dug potatoes may shown no signs of it. When stored in a close bin or left outdoors where it is warm, the fungus is activated and rot soon appears. If stored where the temperature is near freezing, the rot will not develop.

One can be sure that practically all the tubers from a diseased field are infected. They should be stored under cool conditions and later marketed as they are quite fit for food, yet entirely unfit for planting the following year. The best recommendation for control is rotation. Once a field is infected it becomes capable of transmitting the disease to clean seed when planted thereon.

Jelly End Rot. (Fusarium radicicola Woll). This disease may be found in the field at digging time. It causes considerable trouble in the potato regions of western United States as well as certain eastern sections. It works its greatest damage as a storage disease.

The disease attacks the stem end of the tuber. This becomes soft and jelly like. The disease progresses and may soon include the whole potato. If left undisturbed, the skin of the tuber may be left as a shell, the inner fleshy part having been used up.

Below 50° F., this disease is not active in stored potatoes. Potatoes showing signs of this disease should be discarded before storing. The disease readily attacks Pearls, Rural New Yorkers, and the Idaho. Resistant varieties should be substituted, if possible, where the disease is prevalent. The damage caused in South Dakota is slight.

Black Leg. (Bacillus phytophthorus Appel). This disease has been much confused with several others. Fortunately it is not found in abundance in South Dakota. The earliest symptoms are that the plants are below normal in size. The color is pale yellowish green. The stems, petioles and leaves curve upward giving the plant a narrowed aspect. The stem is more or less browned or blackened near the surface of the ground and even into the upper branches. The tissue of the discolored parts die and may decay. Usually the tubers show rot. The disease is carried on in seed. Seed should be carefully selected and disinfected.

Late Blight. (Phytophthora infestans (Mont). DeBary). This is one of the most serious of all potato diseases. Fortunately for the growers of South Dakota it probably does not occur in destructive amounts here. It has been found in Iowa and Minnesota and was once doubtfully reported from South Dakota. It should be carefully watched for. It will appear on the leaf as a blackened or dead area. As it progresses, especially in moist weather, the leaf forms what appears to be water-soaked areas. In the earlier stages the water-soaked areas are bordered by a ring of light green. Often one may see the fungus as a white down on such parts. This is more likely to be true under moist conditions.

After the attack on the leaves, the stem is attacked with similar results. Progress is made to the tuber. On the tuber slightly depressed areas appear. In dry conditions of either ground or bin, the disease continues as a dry rot turning the area of the potato attacked into a dry rotted mass as it progresses toward the center. If conditions are wet, it causes a wet rot possibly even more destructive.

Healthy potatoes only should be used for seed. Spraying will hold the disease in check. The spraying should commence the middle of June and be continued once every two weeks.

Black Heart. Often potatoes develop black heart and are undesirable on the market. This is not due to a disease, but to lack of proper ventilation. When potatoes are stored for any considerable length of time in artificially heated rooms, oxygen is used up. This will cause black heart in a short time. The best way to prevent this trouble is to ventilate properly. Do not pile potatoes into piles of over six feet in thickness, and do not allow them to heat to over 95° F.

Hollow Heart. This trouble is due to too much water. In wet seasons too rapid growth causes internal cavities with brown linings, probably caused by tension due to unequal growth. In wet seasons this can be avoided somewhat by planting closer together so that crowding occurs.

Black Wart. (Chrysophlyctis endobiotica Schilb). This is one of the most serious potato diseases. Fortunately it is not widely distributed in the United States, being confined to eastern states such as Pennsylvania, Maryland, and West Virginia. The parasite lives in the soil for many years.

The disease makes its appearance as spongy outgrowths on the potato tuber, especially at the eyes. These may increase in number and size so that the crop may be entirely destroyed. Often the potatoes rot in the ground thoroughly infecting the soil with the disease. If any suspicious tubers are found they should be sent in to the Agronomy Department, South Dakota State College, Brookings, immediately for examination. Only by close watch will its spread in the United States be successfully checked.

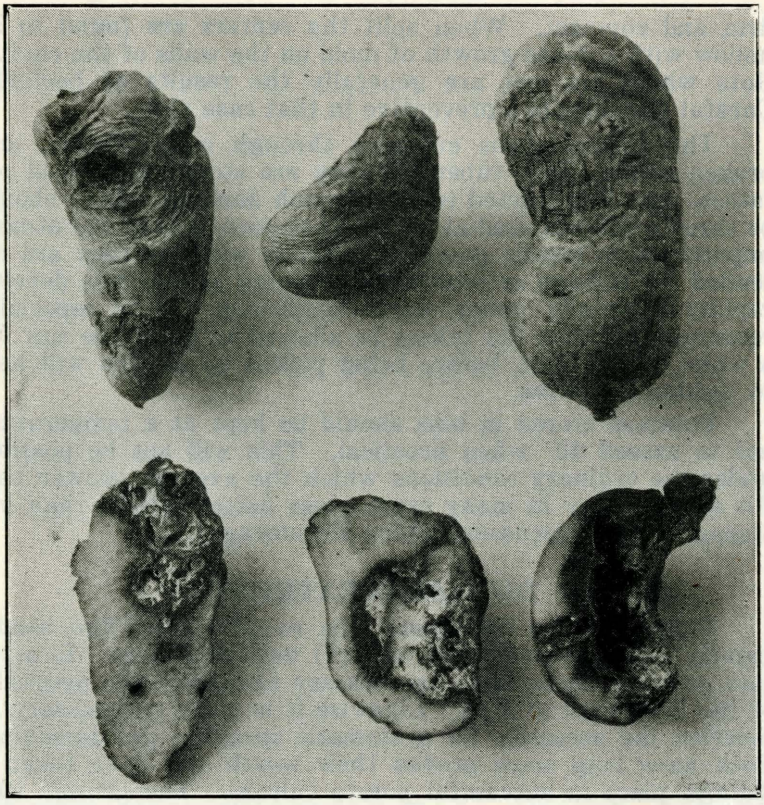

Figure 13. Dry Rot.

Showing several types of rot caused by Fusarium as they look both in the whole potato and in split tubers. The potato in the upper left-hand corner shows distinctly the injury through which the rot entered. The small tuber in the middle has been cut in two in harvesting. Dry rot has entered through the cut surface and has shriveled the potato materially. Note the fungus as it grows in the hollow centers as is shown by split tubers below. The lower right-hand tubers show distinctly on the left margin the injury through which the fungus entered. Such injured potatoes should be discarded when storing.

Dry Rot. There are but few potato growers who have not had trouble with various kinds of rots in storage and shipment. The dry rots are one of the most destructive. These are generally due to the growth of one of several kinds of Fusaria.

Dry rots are usually brownish in color, the skin is dead and wrinkled. There is little if any odor. The rotted part is

firm and compact. When split the centers are found to be hollow with a dense growth of mold on the walls of the cavity. Rots which are wet are generally the results of bacteria. Careful handling is a preventive in that case also.

The fungus gains entrance through cuts, bruises, and broken skins. Such tubers, if they are stored with good potatoes, may be expected to cause much damage. They should be thrown out and used at once. Therefore, it is of the utmost importance to handle potatoes carefully whether they are intended for storage or immediate shipping as dry rots develop rapidly especially under warm conditions. It is especially recommended that the tubers be allowed to lie in the sun for a while, in the field, before being picked up as this will help to tighten the skins.

Potatoes stored in bins should be kept at a temperature not to exceed 40° when practical. This will not be possible under the ordinary conditions which the average grower has. Pit storage may in many cases gives better results than bin storage. (See discussion under bin storage).

DISEASE TREATMENT

Potato disease treatment falls readily under two heads, namely (1) seed treatment, and (2) field treatment. In a potato growing region it is unnecessary to discuss the necessity of the treatment of seed. Likewise it is quite unnecessary to mention the necessity for systematic spraying and poisoning. Both have long since proven their worth and have taken a definite place in successful potato culture. The grower who neglects such treatment may be successful a few years but sooner or later he is bound to suffer a loss which will overshadow all former profits. Again the work of spraying must be done systematically. To try to anticipate the coming of diseases and then check them after they have started is not good business. When one turns to potato growing he should figure on the necessity of at least three sprayings and proceed to apply them as needed. Six sprayings are recommended for South Dakota conditions. These should be at equal intervals or as it seems they are needed, commencing when the potatoes are 5 or 6 inches high.

For convenience the seed treatment will be discussed first, followed by spraying methods.

SEED TREATMENT

Seed treatment consists merely in disinfecting the outer surface of the tubers for the purpose of killing any disease organisms which are present. Only those diseases which are

present upon the surface are killed. It is, therefore, of the utmost importance that tubers with internal diseases be not included in the seed. If when cutting the seed one finds tubers that have dark or brown streaks running through them or that are partially rotted they should be discarded and the cutting knife disinfected in the solution of formaldehyde in which the tubers were treated. Treatment is generally effective against scab and light attacks of Rhizoctonia or black scurf. Corrosive sublimate ($HgCl_2$) is effective against scab and against even very heavy attacks of Rhizoctonia. When, therefore, Rhizoctonia is present in quantity and other clean seed is not available, corrosive sublimate should always be used.

FORMALDEHYDE TREATMENT

Formaldehyde ..... 1 pint
Water ..... 30 gallons

Purchase 1 pint of formaldehyde at any reliable drug store. Mix with the 30 gallons of water. The sacked potatoes may be immersed in this solution for one-half to two-hours. Drain, cut, and plant as soon as possible. Treatment should always be carried on before cutting. For best results the cutting knife should always be sterilized after cutting a diseased potato.

CORROSIVE SUBLIMATE ($HgCl_2$) TREATMENT

Corrosive sublimate ..... 4 ounces
Water ..... 30 gallons

Purchase 4 ounces of corrosive sublimate at a reliable drug store. Dissolve in 30 gallons of water. **This solution is very poisonous and must be kept from children and animals as well as used with discretion by the one doing the work. It must not be used in a metal container.** A wooden tub or barrel is necessary. Immerse the potatoes in the solution and allow them to remain for one-half to one hour. If the sclerotia of Rhizoctonia are large and abundant and no other seed is available it may be well to soak for one and one-half to two hours.

The length of time for treatment is variable. Good results may be obtained by soaking in either solution a shorter time but it is generally agreed that from thirty minutes to one hour is about right.

Often the potatoes will be somewhat sprouted. Corrosive sublimate may injure sprouts if they are left in it too long. Formaldehyde is one of the most widely used disinfectants. The fact that it is cheap and safe is one of which we are not to lose sight. Then, too, the solution can be used over

and over until it is all gone. In fact it becomes stronger with evaporation. On the other hand, while corrosive sublimate is a more powerful disinfectant, it is very poisonous, must be used in wooden containers, and is more costly. It gradually becomes weakened by use and must be replaced (add 4 oz. cor. sub. and water to make up to 30 gal.) after three lots of potatoes have been treated if effective results are to be secured.

The argument is often advanced that corrosive sublimate should replace formaldehyde since treatment with corrosive sublimate will kill all large sclerotia of Rhizoctonia, while with formaldehyde we are not sure. No grower producing potatoes on a large scale is going to plant tubers heavily infected with Rhizoctonia or deeply pitted by scab such as formaldehyde would not obliterate. Then, too, yearly treatment with formaldehyde should keep the seed stock relatively clean and free from disease so that the stronger disinfectant is not necessary. The cost, danger in using, and the inconvenience in handling, alone, will prevent the widespread use of corrosive sublimate.

Many directions for formaldehyde suggest treating and then drying of the treated potatoes. This is not recommended due to the formation of a very effective and penetrating substance which is likely to materially decrease germination. When treated and cut the potatoes should be placed in a pile and allowed to remain until planted. Ordinarily the treated seed should be planted while still wet if possible.

SPRAYING METHODS

Spraying of potato vines is an absolutely essential process if successful culture is to be realized. The attacks of disastrous diseases in the field make it a necessity which must not be overlooked. Bordeaux mixture is the greatest of all sprays for potato diseases in the field. Any patent spray bought will be only a spray based on this one.

Bordeaux mixture can be easily and cheaply made at home. Enough can be made at one time to last throughout the season. Only three ingredients are needed to make bordeaux, i. e. copper sulfate, stone lime (unslacked lime), and water. Ordinarily bordeaux mixture is spoken of as 4-4-50 or 5-5-50, or some other combination which indicates a different strength of solution. The formula 5-5-50 means 5 pounds copper sulfate, 5 pounds stone lime, and 50 gallons of water.

Two barrels are necessary to make up stock solutions. To make the copper sulfate or "blue stone" solution place 40 gallons of water in the barrel. Suspend in the top of the barrel, just submerged in the water, 40 pounds of copper sulfate crystals. This may be done by tying them in a cotton

sack or placing them in a basket. In this way the dissolved solution settles to the bottom and fresh water is always in contact with the crystals. Thus the dissolving will be more rapid. It takes several hours for the copper sulfate to dissolve, so it may be conveniently done overnight. When dissolved there will be 1 pound of copper sulfate for each gallon of water.

In a similar barrel slack 40 pounds of unslacked lime (stone lime). This should be carefully done, only a small amount of water being added at a time until the reaction is complete. When completely slacked allow to cool and then pour into the barrel enough water to make up the rest of 40 gallons. Similarly this solution contains 1 pound of lime to each gallon of water.

If smaller lots or larger lots are wanted, all one needs to remember is to have 1 pound of copper sulfate or 1 pound of lime to each gallon of water. The solutions should be tighly covered so that much evaporation will not occur. These stock solutions will keep indefinitely. The precautions are, not to use burlap for straining the solution as the fibers from it are likely to plug up the spray, also to use only unslacked lime as air-slacked lime is useless in making bordeaux.

With these solutions on hand, one can make up any strength of bordeaux he wishes. If 50 gallons of a 3-3-50 solution are wanted, take 3 gallons of copper sulfate solution and pour through a strainer into the spray tank. Add 22 gallons of water which makes one-half of the desired amount of spray. Dilute 3 gallons of the lime solution with 22 gallons of water in a separate container. Then pour into the spray tank through a strainer in order that material which may plug the spray nozzles will be removed. Agitate it thoroughly and it is ready for use. Similarly a 4-4-50 or 5-5-50 solution can be made by taking 4 gallons or 5 gallons of the solution as desired. The reason for thus mixing is more or less technical, but the results are that the suspensions settle less slowly so that more even distribution is gained on the plants in the field. Bordeaux mixture is of little value after it has been mixed for more than 4 hours. The amount of crop that 50 gallons will cover depends largely on the size of the vines, the rate of spraying and the number of times they are sprayed. If six sprayings are practiced, it may be slightly lighter than where three sprayings are used. Ordinarily 75 to 100 gallons will cover an acre. The 5-5-50 strength of bordeaux is recommended for spraying.

INSECT POISONING

For poisoning potato bugs and leaf hoppers it is best to mix the poison in with bordeaux mixture. Often poisons

may burn the foliage. If used with bordeaux this is avoided on account of the lime present. If paris green is used alone the poison should be mixed with lime water. When paris green is used with bordeaux one to one and one-half pounds are sufficient to 50 gallons. If lead arsenate is used, 3 or 4 pounds are necessary. Lead arsenate is generally to be recommended.

TIME OF SPRAYING

Spraying with bordeaux should begin when the potatoes are from 6 to 8 inches high. For the best results 3 to 6 sprayings are necessary. If six sprayings are practiced they may be light but should be thorough. This would require spraying every 2 weeks. If three sprayings are to be given, then the sprayings must be heavier and will be about 3 weeks apart for the best results. No grower can expect the best results possible with less than three sprayings under South Dakota conditions. Of course, one spraying is better than none, but the potato raiser who expects to make money in the long run by raising potatoes without spraying, considering the diseases he must combat in South Dakota, is laboring under a misapprehension.

SEED BED

A good seed bed is essential to success in potato growing. A proper rotation is necessary in order that the soil shall be in good condition. Potatoes may follow any crop successfully. A cultivated crop has the advantage of keeping the weeds down. The grain crop will also tend to eliminate the weeds so that potatoes the following year will be more easily attended. Then too, fall plowing may be practiced, thus turning under a crop of green manure in the form of weeds or legumes. A legume crop with the last crop turned under will also eliminate the weed nuisance. It has the disadvantages of consuming quite a quantity of water and furnishing an overabundance of nitrogen. Since too great a supply of nitrogen for potatoes is conducive to scab, it is to be used with discretion.

A cultivated crop, such as corn, leaves a good seed bed. The stalks should be removed for silage or as fodder as they are troublesome in cultivating the following year. There is no objection, however, to plowing under such material. In the case of small grains fall plowing may be practiced. Left rough, snow is held and moisture accumulates. Heavy disking and harrowing leaves the ground in good shape for planting the next spring.

The depth of plowing is a matter for consideration. The following yields have been harvested from plats of different depths of plowing at Highmore, planted to Irish Cobblers.

TABLE VIII.

Depth of Plowing*	1915	1916	1917	1918	1919	1920	1921	Average
6 inches	97.7	87.1	63.6	82.0	28.5	43.7	46.6	64.2
12 inches	87.7	85.6	47.8	75.9	14.3	67.0	50.0	61.2

The results show an average of 3 bushels per acre for 7 years in favor of 6 inch plowing. Not only is this a profit from larger yield, but it is also a large item in labor saving over deep plowing.

The following rotations are practiced with success on the experiment station farm at Brookings and the various substations.

Brookings—Corn, potatoes, small grain, white sweet clover. This makes a good short rotation of the best type for the eastern part of South Dakota. It is advisable to plow under the second crop of sweet clover as green manure. This will have to be done before the seed forms, otherwise the growth of plants may be troublesome the following year.

Cottonwood—Alfalfa (5 to 10 years), corn, wheat, white sweet clover (plowed under), potatoes, flax. This rotation yields well and gives fair results at the Cottonwood substation. When the sweet clover fails, the land is planted to field peas and these are plowed under.

Eureka—Alfalfa (7 to 14 years), corn, wheat, white sweet clover (plowed under), millet (cultivated), small grain, potatoes, flax. This is one of our best yielding rotations. The long time rotation of 14 to 21 years gives the land much time to recover from infection by any potato diseases which may infest it. Then too, the crops are such as are best adapted to combat weeds. Cultivation is frequent and green manure tends to eliminate scab from the soil.

Highmore—Alfalfa (4 to 8 years), corn, peas or sweet clover (plowed under), potatoes and flax. This rotation is shorter than the Eureka, but is well adapted to potato culture, i. e., a cultivated crop every other year and a legume crop as green manure.

Green manure is one of the best panaceas we have for freeing soils from scab after they have become infested.

*These data have been contributed by the Soils laboratory of the Agronomy Department of South Dakota Experiment Station

TABLE IX.

DATE OF SEEDING WITH IRISH COBBLERS AT HIGHMORE

THE FOLLOWING RESULTS HAVE BEEN OBTAINED IN A DATE OF SEEDING TEST WITH IRISH COBBLERS AT HIGHMORE:

Date of Seeding	1917	1918	1919	1920	1921	Ave.	Days to Appear
April 15-20....	36.5	75.9	59.7		69.6	60.4	38.7
April 25-30....	55.7	104.6	69.5	40.1	61.2	66.2	32.5
May 15-18	41.5	111.1	74.5	57.9	68.0	70.6	24.5
May 30	33.0	79.0	26.4	55.4	48.3	48.4	20.8

The date of seeding tests at Highmore are complete for 5 years with the exception of the first planting in 1920. The results show May 15 to be the best date of planting for potatoes in that locality. The rate of seeding in each case was 40 pecks, or 10 bushels, per acre. The cold ground undoubtedly has some influence. The number of days before each planting appeared above ground is interesting. The appearance of the plant above the ground in 24.5 days in the case of May 15 to 18 planting is significant. Although the May 30 planting appears in less time than the May 15 to 18 planting, its failure to produce as well may, in part at least, be attributed to the late planting which makes full development almost impossible before early frosts. In general, potatoes should be planted between May 5 and 15, whenever possible, in central South Dakota. Earlier planting is not recommended.

METHOD OF PLANTING

The rotations given are such that cultivated crops should keep the ground reasonably free from weeds with the general amount of care. As drilling is the ordinary way of planting potatoes this is important. Where weeds are allowed to grow in potatoes, the moisture is used, and the potatoes are smothered out. For convenience in cultivation the potatoes on the experimental farms are all hilled. Since no machine which drops in hills has been placed on the market for potatoes this necessitates extra labor. We use a sled marker with four runners which are spaced the necessary distance. By going both ways of a field the points where the runners cross indicate the position of the hills, or land may be furrowed and a corn planter wire used to mark the position of the hills. By hilling potatoes, cultivation both ways with an ordinary cultivator is possible and labor saved. Weeds can be controlled better and yields generally increased. The belief that hilling does not yield as well as drilling is not substantia-

ted by data on the rate and method of seeding experiment which has been conducted at Highmore since 1918. Although this is probably too short a time to draw any definite conclusions yet the data show that neither the very heavy or very light seedings are the desirable types.

TABLE X.

RATE AND METHOD OF SEEDING EXPERIMENT AT HIGHMORE SUBSTATION

	Hills 42 inch	Hills 36 inch	Hills 30 inch	Drills 42"x12"	Drills 36"x12"	Drills 30"x12"	Drills 30"x 6"
1918 ..	121.5	152.2	184.3	142.9	140.3	134.9	77.1
1919 ..	50.42	61.1	61.5	65.4	61.7	52.9	76.1
1920(1)	144.1	159.5	163.0	149.8	89.3	125.9	136.6
1921 ..	75.3	110.6	138.0	125.6	123.4	103.5	37.38
Av. ...	97.83	120.85	136.7	120.92	103.68	104.3	81.79

(1)Planted on rather low land. Drills 42x12, 36x12, and 30x12 not strictly comparable.

The hilled potatoes are understood of course to be the same distance apart each way. By this table it will be seen that 30 inch hilling yields the best, outyielding its nearest competitor in the drilled 42 inches by 12 inches by 13.15 percent, and its nearest competitor in the hilled by 13.2 percent. Our best recommendation as to planting, based on the knowledge which we have, would be to hill potatoes 30 inches apart, each way. Of course most of the potatoes are drilled. Our recommendation based on similar knowledge for drilled potatoes would be to drill in rows 36 to 42 inches apart and 12 inches apart in the row.

The depth of planting should be 5 or 6 inches. This will vary with the season, date of planting, and type of soil.

The rate of planting varies greatly. From 9 to 15 bushels are planted. In hilling the seed used is less than in drilling. The hilling requires about 10 bushels per acre. In ordinary drilling, 12 inches apart, and one seed piece per hill, 12 bushels are considered sufficient. The larger the seed pieces the greater will be the number of bushels. On the experimental plats we cut a potato in two, making two seed pieces. Also two seed pieces are dropped in each hill. This insures a good stand as well as a more vigorous vine and as is shown by resulting Table 10, it nets a greater yield.

Cutting machines are on the market but have objectionable features. Many growers prefer to cut by hand. Hand cutting has many advantages, as proper distribution of eyes

in seed pieces, avoiding contamination from diseased tubers, etc. Where very large acreages are planted, ordinarily hand cutting must be dispensed with in order to speed up planting operations.

Machine planting is necessary where large acreages are planted. There are various makes of one and two man machines for planting either one or two rows at a time, which are dependable. The names of these can be obtained from your implement dealer or this department.

An ordinary corn cultivator can be used successfully for potato plowing. A harrow is one of the very essential implements. Successful potato growing depends upon a good start. The best date of seeding is from May 5 to 18. This gives ample time for seed bed preparation. It should be well packed and thoroughly disked and harrowed just prior to planting. This gets rid of the small weeds which have started. After planting a very thorough blind plowing will remove all weeds which are left. As the potatoes are coming through the ground a careful plowing will remove any weeds which may have started. A good harrowing soon after will level the ground. This can be followed by one or two later harrowings as needed before the potatoes are 6 inches high. The last harrowing may be omitted and the field run over with a weeder to good advantage.

Later plowings should be with surface gophers or towers, merely to maintain moisture and keep weeds from starting. If the first cultivations and harrowings have been thorough no weeds should bother. Should some appear in the rows, hoeing must be resorted to. Lack of hoeing has ruined many a potato crop.

HARVESTING

Potato harvesting machinery is common on the market. Before this machinery, a regular breaking plow was used. Many potatoes were cut or left undug so in general it was wasteful unless the amount to be dug was small.

The principal of the potato digger is to dig up the row, shake out most of the dirt and drop the potatoes behind in the furrow, or elevate into dump hopper. These two methods are the ones in common use. Bruising is always to be avoided. Potatoes carelessly dug are sure to spoil in storage or to be docked in the market. Ordinarily they should be handled as little as possible when dug. If allowed to lie on the ground, they will dry so that little dirt will adhere to them. Careful storing for a while in shallow piles is desirable as it gives an opportunity for the skins to tighten up. This will avoid slipping of the skins which is very undesirable as it affords an entry of disease and is otherwise objectionable.

Many good potato digging machines are on the market. The name of some reliable one can be obtained from your implement dealer or we will gladly furnish you with a list.

STORING

If the tubers are to be stored, they should be carefully picked over, so that no bad ones will get in. Also, all bruised and cut potatoes ought to be thrown out for use immediately. Disease will usually attack them first and once started it becomes destructive and hard to check.

The bin in which potatoes are to be stored should be clean. It should be thoroughly swept and if there has been trouble with rot in it before, it is best to disinfect it. A painting or washing of all inside parts with a solution of 1 pint of formaldehyde in 20 gallons of water is very efficient. After the removal of the last year's crop, the bin should be dried and disinfected ready for receiving the coming crop. Clean dry potatoes, uninjured and stored in a dry bin do not rot unless disease is present in the tubers. One should satisfy himself that they are all right by digging into the bin and examining them from time to time. Storage below 40° F. is recommended whenever possible.

LIST OF AVAILABLE PUBLICATIONS

Annual Reports, 1917, 1918, 1919, 1920.

Bulletins

106. Sugar Beets in South Dakota
129. Growing Pedigreed Sugar Beets
131. Scabies (Mange) in Cattle
132. Effects of Alkali Water on Dairy Products
142. Sugar Beets in So. Dak.
143. Roughage for Fattening Lambs
147. Effect of Alkali Water on Dairy Cows
153. Selecting and Breeding Corn for Protein and Oil in So. Dak.
154. The Pit Silo
156. Kaolian, A New Dry-land Crop
157. Rape Pasture for Pigs in Cornfield
158. Proso and Kaoliang for Table Use
159. Progress in Plant Breeding
160. Silage and Grains for Steers
161. Winter Grain in So. Dak.
162. First Annual Report of Vivian Experiment and Demonstration Farm
163. Comparative Yields of Hay, from Several Varieties and Strains of Alfalfa in South Dakota
164. Making Butter and Cheese on the Farm
165. Corn Silage for Lambs
166. Factors Affecting Milking Machines
167. Transplanting Alfalfa
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182. Corn Silage for Steers
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185. Ice on the Farm
186. Corn Families of So. Dak.
187. The Influence of Length of Wheat Heads on Resulting Crops
188. Relative Values of Feed Proteins for Dairy Cows
189. Corn and Millet Silage for Fattening Cattle
190. The Webspinning Sawfly of Plums and Sandcherries
191. Water as a Limiting Factor in the Growth of Sweet Clover
192. Rations for Pigs
193. Soybeans in South Dakota
194. Acme Wheat
195. Feeding of Dairy Cattle

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