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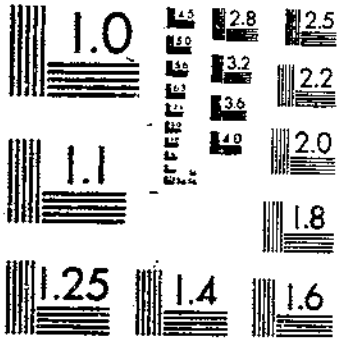

MICROCOPY RESOLUTION TEST CHART
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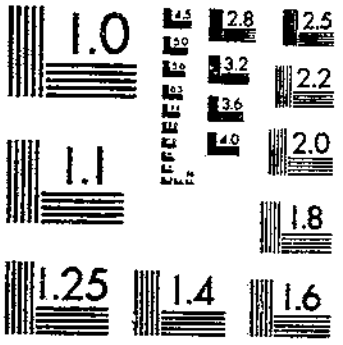

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Technical Bulletin No. 758 · *March 1941*

UNITED STATES
DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

Selenium Occurrence in Certain Soils in the United States, With a Discussion of Related Topics: Fifth Report

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INTRODUCTION

Although the present report is the fifth of a series presented by the Division of Soil Chemistry and Physics, it seems desirable to give a brief outline of fundamentals by way of introduction.

For many years there has been known and described a livestock disorder that occurs in the semiarid Great Plains of the United States. This disorder is known on the Plains as alkali disease, a misnomer applied by early settlers who attributed the trouble to alkali (high-salt) water. The disorder is now known to be selenium poisoning and is caused by the ingestion of vegetation that has absorbed this toxic element from the soil. There are two types of poisoning caused by seleniferous vegetation. One is a chronic malady, and in horses and cattle it manifests itself clinically by an alteration in the growth of hoofs and the loss of hair. There are various gradations in these conditions. In severe cases the coat is bad, the tail is nude and often sore at the tip, the hoofs are malformed, followed eventually by a sloughing off of the old hoofs. Extreme emaciation is also common. The animal either dies or is permanently impaired. The other type of poisoning is acute, and the animal dies in a few hours to a few days after ingestion of the toxic vegetation.

The chronic condition is caused by the daily ingestion of small amounts of selenium, which may be present in cereals, grasses, and other forage plants. The acute poisoning is the result of ingesting larger amounts of selenium, which is present in the so-called indicator or converter plants such as *Astragalus pectinatus*, (Hook.) Dougl., *A. racemosus* Pursh, *A. bisulcatus* (Hook.) A. Gray, *A. carolinianus* L.,

A. grayii, *Stanleya pinnata* (Pursh) Britton, *S. bipinnata* Greene, *Aplopappus fremonti* A. Gray, and *Aster parryi* A. Gray. An *Astragalus racemosus* plant was found that contained 14,920 p. p. m. of selenium on an air dry basis (*24*).[1] In many instances over 50 percent of a herd of animals have died over a period of a few days when taken into an unexpectedly toxic area.

It has been found that relatively small amounts of selenium taken daily disturb the physiological processes. Rats on an adequate diet that was prepared to contain 6 p. p. m. of selenium, by the incorporation of seleniferous cereals, were found to be considerably below normal in weight, and the number of young born and the percentage reared were less than normal. A similar diet containing 3 p. p. m. of selenium had a slight effect on reproduction, although growth was apparently normal (*55*). It has been found that diets containing more than 10 p. p. m. of selenium caused a restriction of growth and food consumption in rats and that diets containing 5 p. p. m. prevented normal growth (*17*). It has been reported that the hatchability of chicken eggs appeared to be slightly reduced when the laying ration included sufficient seleniferous grain to have a selenium content of 5 p. p. m. and became zero when the selenium content was 10 p. p. m. (*41*). Two typical cases of chronic selenium poisoning were produced in a group of five hogs maintained on a diet of corn containing 10 p. p. m. of selenium. With a similar diet of corn containing 5 p. p. m. of selenium no symptoms were produced in the five hogs used (*44*).

During field studies in affected areas the authors have observed selenized animals suffering various gradations of affliction: Pigs that were nearly hairless from ingestion of toxic grain, horses without tail or mane and with deformed hoofs, cows with poor coats and loose hoofs, and bulls impotent from consuming seleniferous forage. These symptoms are accompanied by a poor general condition of the affected animals. It was found that on some farms it was necessary to purchase eggs for setting, because the eggs from the farm flock would not hatch.

Many farmers are familiar with seleniferous (alkalied) grain, and they use various methods to circumvent its toxicity. Some sell their grain and buy good grain for feeding, others know which fields of their farm produce toxic grain and which produce good grain, and others are able to feed a mixture of their grain with good grain obtained elsewhere. These and other similar methods are used to keep the selenium content of the diet low enough so that it does not cause visible trouble.

In previous bulletins (*4*, *5*, *9*, *55*) the authors have reported the progress of the location and delimitation of seleniferous areas, together with considerable other data gained in the survey work. A seleniferous area is defined as an area in which at least some of the vegetation is toxic from selenium. During these surveys two guides have been found that greatly facilitate the work. A great majority of the seleniferous soils are derived from Cretaceous sediments and, therefore, geologic maps aid in the location of areas. Further, it has been found that certain species of *Astragalus* and other plants occur only on these seleniferous soils (*29*).

Because of numerous inquiries concerning the health hazards incurred by people outside of seleniferous areas and relative to some

[1] Italic numbers in parentheses refer to Literature Cited, p. 67.

semipopular publications of the alarmist type, it seemed of paramount importance to determine to what extent foodstuffs which may come into the markets are likely to contain selenium. This bulletin is therefore devoted primarily to a survey of the grain crops of areas known to be seleniferous. In order to make this survey comprehensive, numerous samples of grain from widely different sources were collected and were supplemented by samples furnished by the Food and Drug Administration and the General Mills Co., Inc.

In addition to the study of commercial foodstuffs a reconnaissance survey was made in parts of Alberta, Saskatchewan, and Manitoba, Canada, at the request of Dean L. E. Kirk, of the University of Saskatchewan, Saskatoon, and this survey was continued into a portion of North Dakota. There are also included a number of miscellaneous data bearing on the general problem.

The methods of analysis used to determine the selenium content of the various materials reported in this bulletin have been previously described (*48*, *51*, *54*). The analysis of all grain samples in this bulletin was completed by March 1, 1939. The elapsed time between the first samples analyzed and the completion of the data was insufficient, in the opinion of the authors, to affect the relative selenium contents of the samples (*33*).

RECENT LITERATURE

The great number of articles on the relation of selenium in soils to vegetation and animals and on related topics is proof of the active interest of workers in many fields. In the bulletins of this series (*4*, *5*, *9*, *55*) there has been an attempt to take note of all the recent work on this general subject either in the text as the occasion arose or in a section specifically devoted to the purpose. There follows a brief review of such articles as have come to the writers' attention since the fourth bulletin (*55*) of this series was written.

Horn's modification (*21*) of the codeine sulfate reaction for the detection of selenium has been applied to the quantitative determination of minute amounts of selenium in animal tissues and feces by Gortner and Lewis (*19*). The carefully developed color is tested for light transmission by a photometer and compared with curves determined by measuring light transmission of solutions of known selenium content. The codeine sulfate reaction has been applied by Davidson (*11*) to the quantitative determination of selenium in plant materials.

Curl and Osborn (*10*) found that the digestion temperature, after the rapid initial reaction has slowed down, need not be carefully controlled in the Williams and Lakin method of nitric-sulfuric acid digestion of organic material (*54*) provided 0.5 gm. of mercuric oxide is added to the sample. They also found that the use of starch indicator in the volumetric determination of selenium by reduction of selenious acid by thiosulfate was satisfactory for amounts of selenium above 5 gamma.

The investigation of selenium in Mexico and especially of the disorder known as soliman disease (*6*) was made possible by the assistance of Dr. José Figueroa. The investigation of soliman disease has been continued by Figueroa (*13*). The toxic land is that overflowed by a stream polluted with mine wastes. Animals fed the forage from this

flood plain develop chronic selenium poisoning. Chickens are badly affected by the grain. People living solely on the produce of the area, in some cases, develop nail trouble similar to the hoof disorder of selenized animals. The landowners in the area, aware of the danger of consuming or of feeding their animals the products of their farms, find it expedient to sell their crops and buy food from outside the area.

It has been reported previously that selenate toxicity is lessened by increasing the sulfate supply (*22*) and that the soil colloid has very little effect on selenate toxicity (*18*). Gile and Lakin have made comparative studies on the effect of soil colloids on selenite and selenate toxicity.[2] Their experiments show clearly that soil colloids have a marked effect on the availability or toxicity of the selenite ion; that the effect varies with the kind of colloid; and that toxicity of the selenite ion is not affected by the sulfate supply, provided sufficient sulfate is available for maximum growth. This is in marked contrast to the selenate toxicity that was materially lessened by increasing the sulfate supply and was but little affected by the soil colloid. Both wheat and millet, when injured by sodium selenite, seemed a little darker green than normal. Wheat showed an ivory-white chlorosis and millet more or less yellowing from selenate injury. When millet is injured by selenate the selenium content of the tops is greater than that of the roots, but when injured by selenites the selenium is found preponderantly in the roots.

Westfall and Smith (*49*) studied the separation of selenium from proteins. They found that the selenium that naturally occurs in grain protein can be removed quantitatively under suitable conditions with bromine in hydrobromic acid or with hydrogen peroxide. These reagents apparently caused no gross hydrolysis of the protein nor its disintegration. There is some possibility that it is accompanied by the removal of a certain fraction of nitrogen and sulfur.

The availability of naturally occurring selenium to plants was studied by Olson and Moxon (*37*). They analyzed six soils from seleniferous farms for water-soluble, acid-soluble, organic, and total selenium, and for total and water-soluble sulfur. In the six soils that they used the availability of the selenium depended upon the water-soluble selenium, which in turn seemed to be dependent upon, or correlated with, the amount of organic selenium in the soil. Neither the water-soluble nor total sulfur seemed to be significant in determining the availability of selenium to plants in naturally seleniferous soil.

The loss of selenium by grain during storage was studied by Moxon and Rhian (*33*). The loss was very appreciable, reaching a maximum of 72.7 percent in a sample of barley. This is reported to be in agreement with farmers who state that old grain is less toxic than new.

Olson (*36*) found that the selenium in sprouting grain moved into the roots and stems.

Trelease and Trelease (*46*) have continued the study of selenium as a stimulating or possibly essential element for indicator plants (*1*). In sand and solution cultures it was found that selenium, as selenite, in concentrations from 1 to 27 p. p. m. had a pronounced stimulating effect on the growth of *Astragalus racemosus* and *A. pattersoni* A. Gray. *A. racemosus* tolerated about 10 times the concentration of selenite

[2] GILE, P. L., and LAKIN, H. W. THE INFLUENCE OF SOIL COLLOIDS ON THE TOXICITIES OF SODIUM SELENATE AND SODIUM SELENITE FOR MILLET. Soil Sci. Soc. Amer. Proc. 3: 92-93. 1938. [Mimeographed.]

that can be withstood by wheat and buckwheat. The accumulation of selenium by *A. racemosus* was directly related to the concentration of selenium and inversely related to that of sulfur in the culture solution. *A. racemosus* and *A. crassicarpus* Nutt. were grown in water cultures with selenium, as selenite, in concentrations of from 0 to 9 p. p. m. (*50*). *A. racemosus* was stimulated by the selenium. In contrast, *A. crassicarpus* was poisoned by selenium, being severely injured by a concentration as low as 0.33 p. p. m. (as selenite). The greenhouse tests of growth in artificial media confirmed field observations in showing a physiological differentiation of *Astragalus* species into two groups—those which seem to require selenium for their development and those which do not utilize selenium.

Perkins and King (*38*) reported that applications of selenium to Derby soil up to 2.5 p. p. m. stimulated the spring growth and harvest weight of Tenmarq wheat.

The absorption of selenium by tobacco and soybeans was studied by Martin and Trelease (*26*). Stunting was the only symptom of selenium injury uniformly developed by tobacco. Soybean plants exhibited root lesions and stem intumescences, not previously described as symptoms of selenium injury, in addition to the usual stunting and chlorosis found in other plants.

Hurd-Karrer (*23*) found that within limits the absorption of the selenium of sodium selenate varies directly with the amount available to the plant and inversely with the concentration of sulfate. Even excess sulfate did not entirely prevent the absorption of selenium. The data also showed that the amount of selenium that wheat plants can contain without visible injury depends upon their sulfur content. When the sulfur content was high, 700 p. p. m. of selenium in the tissues produced no visible injury; when it was low, the plants were chlorotic with about one-third of this amount of selenium.

Mason and Phillis (*27, 39*) found that cotton plants could be rendered toxic to cotton stainers (*Dysdercus howardi* Ballou) and pink bollworm (*Platyedia gossypiella* Saund.) by adding sodium selenate to sand cultures. Five goups of plants receiving 0, 5, 10, 20, and 50 p. p. m. of selenium, respectively, were used. Injury to the cotton plants occurred in the groups receiving 20 and 50 p. p. m. of selenium. When fed on green cotton bolls from the 10, 20, and 50 p. p. m. of selenium groups, cotton stainers of the fourth and fifth nymphal stages died in 3 weeks, whereas 60 percent of those fed on green bolls receiving 5 p. p. m. of selenium died. A marked reduction of damaged loculi was observed in seleniferous cotton plants exposed to bollworm attack. Phillis and Mason (*40*) later observed similar results with cotton grown in field plots in which 4, 12, and 24 pounds of sodium selenate to the acre were used.

The industrial hazard of selenium has been studied by Dudley (*12*), who discusses the dangers of dust, vapor, and gas in industrial materials and gives methods of analysis for these materials. He reports that normal human urine does not contain selenium. This is not the experience of the authors. Selenium in readily detectable amounts has been found in all normal urine samples examined (see table 9).

Wright (*56*) found that sodium selenite and selenate inhibit the oxygen consumption in vitro of liver, kidney, brain, muscle, and tumor slices. Selenite-poisoned tissues are not able to oxidize glucose

or succinic, lactic, pyruvic, or citric acids, but rapidly oxidize *p*-phenylenediamine.

Westfall, Stohlman, and Smith studied the placental transmission of selenium (*50*). Selenium is transmissible through the placenta to the mammalian fetus whether fed as inorganic or as naturally occurring organic food selenium. More selenium is stored in the fetus when the diet of the mother contains naturally occurring organic food selenium than when it contains sodium selenite. Deformities such as have been described in chick embryos (*14, 15, 16*) produced by selenium were not seen in any of the fetuses of rats or cats used in the present experiments.

Smith, Westfall, and Stohlman (*45*) report that the excretion level of selenium in the urine is higher in animals chronically poisoned with inorganic selenium than when similarly poisoned with naturally occurring organic selenium. There is a far greater retention of selenium in the tissues of animals chronically poisoned with naturally occurring organic selenium than with inorganic selenium. The selenium stored in the tissues in the course of chronic poisoning with organic selenium is, for the most part, in protein combinations. A small amount, probably representing the end product or products of its metabolism, is nonprotein. The urinary selenium in all cases is recoverable quantitatively by simple distillation with a mixture of bromine, hydrobromic acid, and sulfuric acid. Little, if any, of the urinary selenium is in volatile form. Little, if any, inorganic selenium is demonstrable in animals chronically poisoned with organic selenium.

Moxon (*31*) reported that 5 p. p. m. of arsenic as sodium arsenite in the drinking water of rats appeared to prevent the characteristic symptoms of selenium poisoning of rats, including the prevention of liver damage when the diet contained as much as 15 p. p. m. of selenium from naturally seleniferous grain. It appears that arsenic is effective against inorganic selenium also.

Miller and Schoening (*30*) were able to produce clinical symptoms similar to those seen in natural cases of chronic selenium poisoning by the addition of sodium selenite to the normal grain ration of pigs. The animals lost their hair, and their hoofs began to develop abnormally. The control pigs on the same grain to which no sodium selenite had been added remained healthy. It was found that after the first few days the pigs ate sparingly of the grain treated with sodium selenite. However, after refusing the treated grain, they would readily eat untreated grain.

Williams, Lakin, and Byers (*55*) reported the results of a survey of the seleniferous areas in Montana, a selenium survey in Mexico, some nontoxic seleniferous soils of Puerto Rico, together with some miscellaneous data.

A short history and review of the work on the selenium problem has been prepared by Williams (*52*).

Hance (*20*) prepared a short review of the literature on the selenium problem. He adds that no selenium was found in a large sample of human teeth.

Manville (*25*) has reviewed the literature with special attention to the public health aspects of the selenium problem.

Moxon, Olson, Searight, and Sandals (*32*) investigated the Cretaceous formations of South Dakota for selenium. They found the selenium content of the Dakota, Graneros, Greenhorn, and Carlile

formations to be low. The Smoky Hill member of the Niobrara formation is high, whereas that of the Fort Hayes is low. The Sharon Springs member of the Pierre is directly above the Smoky Hill member of the Niobrara, and it is also high. The Mobridge member of the Pierre formation is locally high, the Sully and Virgin Creek generally low, and the scant information suggests that the Elk Butte is also low. A close relationship between the formation, type of vegetation, and selenium content of vegetation is found to exist.

Byers (*7*) reports the analyses of samples of 18 meteorites for selenium. These data, together with additional information, are given in tables 10 and 11.

The use of indicator plants in locating seleniferous areas has been reported previously (*55*). Beath, Gilbert, and Eppson (*2*) have classed as indicator plants all species of *Stanleya, Aplopappus* (*Oonopsis*) sp. and *Xylorrhiza* thus far studied. Only those species of *Astragalus* that occur in 5 of the 29 groups, as classified by Jones (*2*), were found to be selenium indicators. They reported that indicator plants are seldom found above an elevation of 8,500 feet. In a later paper Beath, Gilbert, and Eppson (*3*) presented data on the distribution of selenium indicators in 12 western States. Seleniferous plants were found on numerous geological formations from late Paleozoic to Quaternary in age.

SELENIUM CONTENT OF WHEAT AND WHEAT PRODUCTS FROM SELENIFEROUS AREAS

One of the authors collected the samples reported in table 1 by following the wheat harvest through Colorado, Kansas, Nebraska, South Dakota, Wyoming, Montana, and North Dakota. The places of collection were in the seleniferous areas or, if outside the areas, were those places believed to handle some grain from such areas. Samples of wheat were collected primarily at elevators in shipping centers. Wheat and wheat products were obtained from flour mills. Also, samples were collected from fields, storage bins on farms, and trucks hauling from farms.

Although the number of places where samples were collected in Colorado and Kansas compare favorably with the other areas from the standpoint of the amount of wheat grown on seleniferous soil, the number of samples is, by comparison, smaller than from the other areas. This difference is due to a deliberate change in the sampling program started after leaving Colorado and Kansas.

The selenium content of the samples, together with the information concerning them, obtained at the time of collection, are given in table 1. The samples are listed under the place of collection and are from the 1938 harvest unless otherwise stated. If the sample was grown elsewhere, this is noted under Remarks. The data are arranged alphabetically by States and by counties within a State. The samples collected by the Food and Drug Administration are reported in table 2 and those submitted by the General Mills Co., Inc., in table 3.

TABLE 1.—*Selenium content of wheat and wheat products* [1]

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
			BENT COUNTY, COLO.		
B23372	5C	Las Animas	Winter wheat	*P. p. m.* 2	Irrigated.
			OTERO COUNTY, COLO.		
B23357	1E	Fowler	Winter wheat	3	Irrigated.
B23366	4A	La Junta	Mixed winter and spring wheat.	3	Do.
			PROWERS COUNTY, COLO.		
B23374	6B	Lamar	Winter wheat	0.5	Irrigated.
			GOVE COUNTY, KANS.		
B23417	25A	SW¼ sec. 6, T. 13 S., R. 28 W.	Ripe wheat heads	2	Gathered in field.
B23418	26A	Sec. 33, T. 13 S., R. 28 W.	Wheat	1	Collected from combine in field.
B23419	27A	Sec. 7, T. 14 S., R. 27 W.	do	1	Do.
B23421	28A	Center sec. 16, T. 15 S., R. 27 W.	Ripe wheat heads	2	Gathered in field.
B23422	29A	Sec. 31, T. 15 S., R. 27 W.	Wheat	3	Collected from combine in field.
B23434	41A	Quinter	do	.5	Composite from 3 elevators.
B23435	42A	Buffalo	do	.3	Do.
B23436	43A	Grainfield	do	.5	Do.
B23437	44A	Grinnell	do	.3	Do.
B23438	45A	Campus	do	1	Composite from 2 elevators.
			GRAHAM COUNTY, KANS.		
B23450	53A	E½ corner sec. 1, T. 9 S., R. 23 W.	Wheat heads	5	Gathered in field.
B23451	54A	Hill City	Wheat	2	Composite from 2 elevators.
B23452	54AA	Bogue	do	1	Composite from 3 elevators.
B23453	55A	Sec. 4, T. 9 S., R. 21 W.	do	3	Taken from truck in field.
			LANE COUNTY, KANS.		
B23423	30A	Shields	Wheat	0.5	Collected at elevator.
B23424	31A	Healy	do	.5	Composite from 2 elevators.
B23425	32A	Pendennis	do	1	
			LOGAN COUNTY, KANS.		
B23438	17A	NW corner sec. 13, T. 14 S., R. 35 W.	Wheat	1	Gathered in field.
B23439	46A	Oakley	do	<.1	Composite from 4 elevators.
B23443	47A	SW corner sec. 34, T. 13 S., R. 32 W.	do	1	
B23444	48A	Monument	do	2	Composite from 3 elevators.
B23445	49A	Page City	do	2	Composite from 2 elevators.
B23446	50A	Winona	do	.5	Do.
B23447	51A	N½ sec. 34, T. 14 S., R. 37 W.	do	3	Representative of a freight-car shipment.

[1] Unless otherwise specified, the sample represents grain from an elevator or mill bin.

TABLE 1.—*Selenium content of wheat and wheat products*—Continued

NESS COUNTY, KANS.

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B23426	33A	Utica	Wheat	1	Composite from 3 elevators.
B23427	34A	Arnold	do	.5	Do.
B23428	35A	Ransom	do	.5	Do.

PHILLIPS COUNTY, KANS.

B23458	60A	Glade	Wheat	0.5	Collected from elevator.
B23459	61A	NW¼ sec. 26, T. 4 S., R. 18 W.	do	.5	Collected from combine in field.
B23460	62A	Phillipsburg	do	1	Composite from 2 elevators.

ROOKS COUNTY, KANS.

B23454	56A	Sec. 1, T. 7 S., R. 19 W.	Wheat	2	Collected from combine in field.
B23455	57A	Sec. 26, T. 7 S., R. 19 S.	do	.5	Collected from truck in field.
B23456	58A	Stockton	do	2	Composite from 4 elevators.

TREGO COUNTY, KANS.

B23429	36A	Sec. 19, T. 15 N., R. 23 W.	Wheat	5	Collected from combine in field.
B23430	37A	Sec. 28, T. 14 S., R. 23 W.	do	1	Collected from bin on farm.
B23431	38A	Sec. 9, T. 13 S., R. 23 W.	do	.5	Collected from combine in field.
B23432	39A	Wakeeney	do	.5	Composite from 4 elevators.
B23433	40A	Collyer	do	1	Composite from 3 elevators.
B23448	52A	N½ sec. 15, T. 11 S., R. 23 W.	do	1	Collected from combine in field.

WALLACE COUNTY, KANS.

B23388	12A	Weskan	Winter wheat	4	
B23390A	13A	Sharon Springs	do	.5	
B23406	20A	Wallace	Wheat	.5	
B23408	21A	SW corner sec. 18, T. 14 S., R. 38 W.	Ripe wheat heads	2	Gathered in field.
B23411	22A	NE corner sec. 27, T. 14 S., R. 38 W.	do	1	Do.

BIG HORN COUNTY, MONT.

B24049	158A	Wyola	Winter wheat	0.5	
B24050	158B	do	Spring wheat	.2	
B24051	158C	do	Winter wheat	.2	
B24052	159A	Lodge Grass	do	.2	
B24053	159B	do	do	.2	
B24054	159C	do	Spring wheat	.2	
B24055	159D	do	Winter wheat	.1	
B24056	159E	do	do	.2	
B24059	160A	Hardin	do	.5	Irrigated.
B24060	160B	do	do	.2	
B24061	160C	do	do	.5	
B24062	160D	do	do	1	
B24063	160E	do	Spring wheat	1	
B24064	160F	do	Winter wheat	.5	
B24067	160f	do	do	.5	From Sheridan, Wyo.

TABLE 1.—*Selenium content of wheat and wheat products*—Continued

BIG HORN COUNTY, MONT.—Continued

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B24068	161A	Hardin	No. 1 hard winter wheat	0.5	Composite from 5 farms.
B24069	161B	do	No. 2 hard winter wheat	.5	From a farm.
B24070	161C	do	No. 1 hard winter wheat	.5	Composite from 3 farms.
B24071	161D	do	No. 1 spring wheat	.2	Composite from 12 farms.
B24072	161E	do	No. 2 spring wheat	.5	Composite from 2 farms.
B24073	161F	do	Winter wheat	.2	1937 crop.
B24074	161G	do	Spring wheat	.5	Do.
B24078	162A	do	Winter wheat	.5	Elevator bin 12.
B24079	162B	do	do	<.1	Elevator bin 1.
B24080	162C	do	do	.1	Elevator bin 2.
B24081	162D	do	do	.2	Elevator bin 5.
B24082	162E	do	do	1	Elevator bin 11.
B24083	162F	do	Spring wheat	2	Elevator bin 4.
B24085	163A	Grown 24 miles east of Billings on Pryor Creek.	do	.1	Collected from truck on highway.

BLAINE COUNTY, MONT.

B24440	284A	Lohman	Spring wheat	0.2	
B24441	285A	Chinook	do	.2	
B24443	286A	do	do	1	Composite from 7 farms.
B24444	286B	do	No. 1 winter wheat	1	Composite from 2 freight cars.
B24445	287A	do	Flour	.5	
B24446	287B	do	Bran	2	
B24447	287C	do	Shorts	2	
B24448	287D	do	Middlings	1	
B24449	287E	do	Tempered wheat	1	
B24450	287F	do	Breakfast food	.2	
B24451	287G	do	Spring wheat	.2	Composite from 26 farms.
B24452	287H	do	Winter wheat	.5	From 1 farm.
B24453	288A	Zurich	Spring wheat	.5	Composite from 8 farms.
B24454	289A	Harlem	do	1	Composite from 9 farms.
B24455	290A	do	do	<.1	From a freight carload.
B24456	290B	do	do	1	From a freight-car bed.

CARTER COUNTY, MONT.

B34806	129B	NE ¼ sec. 10, T. 9 S., R. 60 E.	Spring wheat heads	<0.1	Gathered in field.

CASCADE COUNTY, MONT.

B24223	213A	Great Falls	No. 1 winter wheat	<0.1	
B24224	213B	do	do	<.1	A freight carload from Judith Basin County.
B24225	213C	do	No. 2 winter wheat	<.1	A freight carload from Chouteau County.
B24226	213D	do	No. 1 winter wheat	.5	Do.
B24227	213E	do	do	1.1	A freight carload from Cascade County.
B24228	213F	do	No. 3 spring wheat	1	A freight carload from Chouteau County.
B24229	213G	do	No. 1 spring wheat	.5	A freight carload from Hill County.
B24230	213H	do	Baker's flour	.5	
B24231	213I	do	Family flour	.5	
B24232	213J	do	Flour	.5	
B24233	213K	do	do	.5	
B24234	213L	do	do	.2	
B24235	213M	do	Whole-wheat flour	.2	
B24236	213N	do	Germ flakes	.5	
B24237	213P	do	Bran	.5	
B24238	213Q	do	Shorts	.5	
B24239	213R	do	Spring wheat	.5	
B24240	213S	do	Winter wheat	.5	
B24241	214A	do	No. 1 winter wheat	.5	Freight carload from Cascade County.

TABLE 1.—*Selenium content of wheat and wheat products*—Continued

CASCADE COUNTY, MONT.—Continued

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B24242	214B	Great Falls	No. 2 spring wheat	<0.1	Freight carload from Pondera County.
B24243	214C	do	No. 1 winter wheat	.2	Freight carload from Chouteau County.
B24244	214D	do	No. 4 spring wheat	1	Freight carload from Teton County.
B24245	214E	do	No. 3 spring wheat	1	Do.
B24246	214F	do	No. 2 spring wheat	.5	Freight carload from Hill County.
B24247	214G	do	No. 1 winter wheat	<.1	Freight carload from Yellowstone County.
B24248	215A	do	Family flour	.5	
B24249	215B	do	Baker's flour	.5	
B24250	215C	do	Flour	.5	
B24251	215D	do	do	.5	
B24252	215E	do	do	<.1	
B24253	215F	do	do	.5	
B24254	215G	do	do	.5	
B24255	215H	do	do	.5	
B24256	215I	do	Whole-wheat flour	.5	
B24257	215J	do	Germ flour	1	
B24258	215K	do	Bran	2	
B24259	215L	do	Shorts	.5	
B24260	215M	do	Blended wheat	.5	
B24261	215N	do	do	.5	
B24262	216A	do	Winter wheat	.2	
B24263	216B	do	do	.5	
B24264	216C	do	do	.2	
B24265	216D	do	do	<.1	Freight carload from Colorado.
B24266	216E	do	Spring wheat	<.1	Composite from 4 farms, 10–15 miles north of town.
B24267	216F	do	do	1	1937 crop.
B24268	216G	do	do	.5	Do.
B24287	220A	Vaughn	do	<.1	
B24288	220B	do	Winter wheat	.2	

CHOUTEAU COUNTY, MONT.

B24185	197A	Square Butte	Winter wheat	0.2	Composite from 14 farms, 2–12 miles east of town.
B24186	197B	do	Spring wheat	1	Composite from 2 farms, 2–8 miles east of town.
B24187	198A	do	Winter wheat	.5	Composite from 13 farms, 2–12 miles east of town.
B24188	198B	do	Spring wheat	1	Composite from 5 farms, 2–12 miles east of town.
B24189	198C	do	Winter wheat	<.1	From freight carload.
B24190	199A	do	do	.2	Composite from 20 farms, from 18 miles east and 24 miles northeast of town.
B24191	199B	do	Spring wheat	.2	Composite from 14 farms, from 18 miles east and 24 miles northeast of town.
B24192	200A	Geraldine	Winter wheat	.2	Composite from 10 farms.
B24193	200B	do	Spring wheat	<.1	1937 and 1938 crop from freight carload.
B24194	200C	do	do	.2	Composite from 10 farms.
B24195	201A	do	Winter wheat	<.1	Composite from 9 farms.
B24196	201B	do	Spring wheat	.2	Composite from 3 farms.
B24197	202A	Square Butte	Winter wheat	.5	Composite from 26 farms.
B24198	202B	do	Spring wheat	1	
B24200	203A	do	Winter wheat	.5	Composite from 17 farms.
B24201	203B	do	Spring wheat	<.1	Composite from 5 farms.
B24202	204A	Fort Benton	Winter wheat	.5	Composite from 33 farms.
B24203	204B	do	Spring wheat	<.1	Composite from 4 farms.
B24204	205A	do	Winter wheat	1	Composite from 14 farms.
B24205	205B	do	do	1	From freight carload.
B24206	205C	do	Spring wheat	.5	
B24207	206A	do	Winter wheat	.5	Composite from 20 farms.
B24208	206B	do	Spring wheat	1	Composite from 4 farms.
B24209	207A	do	Winter wheat	1	Composite from 31 farms.
B24210	207B	do	Spring wheat	.5	Composite from 4 farms.
B24211	208A	Tunis	Winter wheat	.5	Composite of wheat grown within 5 miles of town.
B24212	208B	do	Spring wheat	1	Do.
B24213	209A	Carter	Winter wheat	.5	

TABLE 1.—*Selenium content of wheat and wheat products*—Continued

CHOUTEAU COUNTY, MONT.—Continued

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B24214	209B	Carter	Spring wheat	0.5	Composite from 4 farms.
B24215	210A	do	Winter wheat	.5	
B24216	210B	do	do	.5	From freight carload.
B24217	210C	do	do	.5	
B24218	211A	do	do	2	
B24219	211B	do	Spring wheat	.5	Composite from 6 farms.
B24220	212A	do	Winter wheat	.2	
B24221	212B	do	Spring wheat	.5	
B24222	212C	do	do	.5	

DANIELS COUNTY, MONT.

B24529	315A	Scobey	Spring wheat	0.5	Composite from 8 farms.
B24530	316A	do	do	.5	
B24531	317A	do	do	.5	Composite from 3 farms.
B24533	318A	do	Flour	.5	
B24534	318B	do	do	.2	
B24535	318C	do	Bran	.5	
B24536	318D	do	Shorts	.5	
B24537	318E	do	Whole-wheat flour	.5	
B24538	318F	do	Whole-wheat breakfast food.	.2	
B24539	318G	do	Spring wheat	.5	
B24540	318H	do	do	.5	Composite from 12 farms.
B24541	319A	Flaxville	do	.2	
B24542	320A	do	do	.2	Composite from 15 farms.

FERGUS COUNTY, MONT.

B24123	170A	Grassrange	Spring wheat	0.5	
B24130	173A	Lewistown	Winter wheat	<.1	
B24131	173B	do	Spring wheat	<.1	1937 crop.
B24132	174A	do	Winter wheat	.2	Composite from 3 farms.
B24133	175A	Hilger	do	.5	
B24134	175B	do	Spring wheat	.2	
B24135	176A	Moulton	Winter wheat	<.1	Composite from 2 farms.
B24136	176B	do	Spring wheat	<.1	
B24137	176C	do	Winter wheat	.2	1937 crop.
B24138	177A	Suffolk	do	.2	
B24139	177B	do	Spring wheat	<.1	
B24140	178A	do	Winter wheat	<.1	
B24141	178B	do	Spring wheat	.2	
B24142	179A	Winifred	Winter wheat	<.1	Composite from 3 farms.
B24143	179B	do	Spring wheat	<.1	Composite from 4 farms.
B24244	180A	do	Winter wheat	.2	Composite from 10 farms within 5 miles of town.
B24245	180B	do	Spring wheat	.5	Composite from 3 farms.
B24247	181A	do	Winter wheat	.2	Composite from 4 farms.
B24146	181B	do	Spring wheat	.2	Composite from 2 farms.
B24149	182A	Brooks	Winter wheat	.2	Composite from 4 farms within 5 miles of town.
B24150	183A	do	do	<.1	Composite from 19 farms.
B24151	184A	Danvers	do	<.1	Composite from 3 farms.
B24152	184B	do	Spring wheat	.2	Do.
B24153	184C	do	Winter wheat	2	From 5 miles east of town, irrigated.
B24154	185A	do	Winter wheat	.2	Composite from 6 farms.
B24155	185B	do	Spring wheat	.2	Composite from 3 farms.
B24156	185C	do	Winter wheat	.2	Irrigated.
B24157	186A	Hoosac	Spring wheat	.2	
B24158	186B	do	do	1.0	From freight carload.
B24159	186C	do	do	.5	Composite from 6 farms.
B24160	187A	do	Winter wheat	.2	Composite from 13 farms within 5 miles of town.
B24161	187B	do	Spring wheat	.5	Composite from 5 farms within 5 miles of town.
B24162	188A	Denton	Winter wheat	.2	Composite from 7 farms.
B24163	188B	do	do	.2	
B24164	188C	do	Ceres wheat	.2	From 16 to 26 miles east of town.
B24165	188D	do	Marquis wheat	<.1	Do.
B24166	189A	do	Winter wheat	.5	Composite from 20 farms.
B24167	189B	do	Spring wheat	<.1	Composite from 7 farms.
B24168	190A	do	Winter wheat	<.1	Composite from 15 farms.

TABLE 1.—*Selenium content of wheat and wheat products*—Continued

FERGUS COUNTY, MONT.—Continued

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B24169	190B	Denton	Spring wheat	<0.1	Composite from 10 farms.
B24170	191A	do	Winter wheat	.2	Composite from 9 farms.
B24171	191B	do	Spring wheat	.5	From 1 farm.
B24172	192A	Coffee Creek	Winter wheat	.2	Composite from 6 farms.
B24173	192B	do	Spring wheat	.2	Do.
B24174	192C	do	Winter wheat	.5	From freight carload.
B24175	193A	do	do	<.1	Composite from 15 farms.
B24176	193B	do	Spring wheat	<.1	Composite from 2 farms.

GLACIER COUNTY, MONT.

B23990	249A	Cut Bank	Spring wheat	0.2	Representative of 1937 crop.
B23991	249B	do	do	.2	From 1 mile east of town.
B24366	248A	do	do	<.1	From a farm 10 miles east of town.
B24367	248B	do	Winter wheat	.5	Composite from 2 farms.
B24370	248E	do	Spring wheat	1	From a farm 8 miles north of town.
B24372	250A	do	Winter wheat	.2	

HILL COUNTY, MONT.

B24405	267A	Rudyard	Spring wheat	0.2	Composite from 31 farms.
B24406	267B	do	do	.5	From freight carload.
B24407	267C	do	Winter wheat	.5	Do.
B24408	268A	do	Spring wheat	1	Composite from 16 farms.
B24409	269A	do	do	.5	Composite from 5 farms.
B24410	269B	do	Winter wheat	.5	Composite from 2 farms.
B24411	270A	do	Spring wheat	.5	Composite from 20 farms.
B24411A	271A	Hingham	do	<.1	Composite from 25 farms.
B24412	272A	do	do	.2	Composite from 12 farms.
B24413	273A	Gildford	do	.5	Composite from 21 farms.
B24414	273B	do	do	.5	From freight carload.
B24415	274A	do	do	.5	Composite from 9 farms.
B24416	274B	do	do	1	From freight carload.
B24417	275A	do	do	.2	Composite from 15 farms.
B24418	275B	do	No. 1 spring wheat	.5	From freight carload.
B24419	275C	do	do	.5	Do.
B24420	276A	Kremlin	Spring wheat	.5	Composite from 7 farms.
B24421	277A	do	do	.5	Composite from 21 farms.
B24422	278A	do	No. 3 spring wheat	.2	From freight carload.
B24423	278B	do	Winter wheat	1	
B24424	278C	do	Spring wheat	.5	Composite from 17 farms.
B24425	279A	Fresno	do	<.1	
B24426	280A	Havre	do	1	Composite from 35 farms.
B24432	281A	do	do	.5	Composite from 8 farms.
B24433	281B	do	Winter wheat	.5	Composite from 2 farms.
B24436	282A	do	Spring wheat	.5	
B24439	283A	do	do	1	Composite from 10 farms.

JUDITH BASIN COUNTY, MONT.

B24177	194A	Arrow Creek	Winter wheat	0.2	Composite from 10 farms.
B24178	194B	do	Spring wheat	<.1	Composite from 2 farms.
B24179	195A	do	Winter wheat	.2	Composite from 5 farms.
B24180	195B	do	do	.2	From freight carload.

LIBERTY COUNTY, MONT.

B24388	257A	Lothair	Spring wheat	0.5	
B24389	258A	do	do	.5	Composite from 11 farms.
B24390	259A	Tiber	No. 1 spring wheat	1	
B24391	260A	Chester	Spring wheat	.2	Composite from 9 farms.
B24392	260B	do	No. 3 spring wheat	<.1	
B24393	261A	do	Spring wheat	.5	Composite from 25 farms.
B24394	261B	do	Winter wheat	2	Composite from 3 farms.
B24395	261C	do	No. 2 spring wheat	2	From freight carload.
B24397	262A	do	Spring wheat	2	Composite from 8 farms.
B24398	263A	Joplin	do	.5	
B24399	264A	do	do	.5	Composite from 19 farms.
B24400	265A	do	do	.2	Composite from 8 farms.
B24401	266A	do	do	1	Composite from 12 farms.
B24402	266B	do	Winter wheat	.5	From freight carload.
B24403	266C	do	No. 2 spring wheat	.2	Do.
B24404	266D	do	do	.5	Do.

TABLE 1.—*Selenium content of wheat and wheat products*—Continued

PETROLEUM COUNTY, MONT.

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B24125	171B	Winnett	Spring wheat	1	Composite from 2 farms.
B24126	171C	do	do	.2	From Garfield County.

PHILLIPS COUNTY, MONT.

B24457	291A	Dodson	Spring wheat	0.5	
B24459	292A	Wagner	do	.2	Composite from 29 farms.
B24460	293A	Malta	do	.2	Composite from 41 farms.
B24461	293B	do	do	.2	From freight carload.
B24462	293C	do	No. 2 spring wheat	.2	Do.
B24463	293D	do	No. 1 spring wheat	.5	Do.
B24464	293E	do	do	.2	Do.
B24467	294A	do	Spring wheat	.5	Composite from 10 farms.
B24468	294B	do	do	<.1	From freight carload.
B24469	294C	do	Winter wheat	<.1	
B24473	295A	do	Spring wheat	.2	Composite from 7 farms.
B24474	295B	do	Wheat	.2	Irrigated.
B24475	295C	do	Spring wheat	1	From a farm 40 miles south of town.
B24476	295D	do	do	<.1	From a farm 5 miles southeast of town.
B24477	296A	Bowdoin	do	.2	Composite from 5 farms.
B24478	296B	do	do	<.1	Do.
B24479	297A	Saco	do	1	Composite from 11 farms.
B24480	297B	do	No. 3 spring wheat	.5	From freight carload.
B24481	297C	do	Winter wheat	.5	From a farm 3 miles east of town.
B24482	298A	do	Spring wheat	.5	Composite from 15 farms.
B24483	298B	do	No. 4 spring wheat	1	From freight carload.

PONDERA COUNTY, MONT.

B24329	236A	Conrad	Spring wheat	1	Composite from 4 farms.
B24330	236B	do	Winter wheat	.5	From a farm 14 miles north of town.
B24331	237A	do	No. 1 winter wheat	.5	Composite from 3 farms.
B24332	237B	do	Spring wheat	2	Composite from 5 farms.
B24333	238A	do	do	.5	From a farm 12 miles north of town (low protein).
B24334	238B	do	do	1	From a farm 12 miles north of town (high protein).
B24335	238C	do	do	3	From a farm 4 miles south of town (1937 crop).
B24336	239A	do	do	1	Composite from 20 farms.
B24337	239B	do	do	2	From freight carload.
B24341	240A	do	do	1	Composite from 18 farms.
B24342	240B	do	do	1	From freight carload.
B24345	242A	Brady	do	.5	Composite from 2 farms.
B24346	242B	do	do	.5	From freight carload.
B24347	242C	do	Winter wheat	1	
B24355	243A	do	do	<.1	
B24356	243B	do	Spring wheat	1	Composite from 4 farms.
B24357	244A	do	do	1	Composite from 10 farms.
B24358	244B	do	do	.5	From freight carload.
B24359	244C	do	Winter wheat	.2	
B24360	245A	Valier	No. 1 winter wheat	.2	From a farm 3½ miles east of town.
B24361	245B	do	Spring wheat	.5	
B24362	246A	do	do	.5	From a farm 10 miles north of town.
B24363	246B	do	do	.5	From a farm 9 miles north of town.
B24364	246C	do	Winter wheat	.2	From a farm 8 miles southwest of town.

ROOSEVELT COUNTY, MONT.

B24518	310A	Wolf Point	Spring wheat	0.2	Composite from 15 farms.
B24519	310B	do	do	.5	Composite from 12 farms.
B24520	310C	do	Winter wheat	1	1937 crop.
B24521	310D	do	do	.5	

TABLE 1.—*Selenium content of wheat and wheat products*—Continued

ROOSEVELT COUNTY, MONT.—Continued

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B24522	311A	Wolf Point	Spring wheat	0.2	Composite from 24 farms.
B24523	312A	do	Flour	.2	
B24524	312B	do	Bran and shorts	.5	
B24525	312C	do	Whole-wheat flour	.5	
B24526	312D	do	No. 2 spring wheat	<.1	
B24527	313A	do	Spring wheat	<.1	Composite from 30 farms.
B24528	314A	Macon	do	.5	Composite from 9 farms.
B24552	324A	Froid	do	.6	Composite from 32 farms.
B24553	325A	Culbertson	do	.5	Composite from 10 farms.
B24554	325B	do	do	.5	From a farm 20 miles southwest of town.
B24555	326A	do	do	.2	Composite from 2 farms.
B24556	327A	do	do	.5	Composite from 8 farms.
B24557	328A	Bainville	do	.2	Composite from 15 farms.
B24558	328B	do	Spring wheat No. 4	.2	From freight carload.
B24559	328C	do	No. 3 spring wheat	.5	Do.
B24560	329A	do	Spring wheat	.2	Composite from 11 farms.

SHERIDAN COUNTY, MONT.

B24543	321A	Redstone	Spring wheat	0.2	Composite from 11 farms.
B24544	322A	Plentywood	do	.5	
B24546	323A	Antelope	Flour	.5	
B24547	323B	do	Bran	.5	
B24548	323C	do	Shorts	1	
B24549	323D	do	Spring wheat	1	
B24550	323E	do	do	.5	
B24551	323F	do	Breakfast food	.5	

TETON COUNTY, MONT.

B24290	221A	Fairfield	Spring wheat	0.2	1937 crop.
B24293	222C	do	do	<.1	1937 crop; irrigated.
B24294	223A	Bole	do	<.1	From a farm 2 miles east of town.
B24295	223B	do	do	1	From a farm 3 miles northwest of town.
B24296	223C	do	No. 2 winter wheat		Do.
B24297	224A	do	Spring wheat	.5	From a farm 2 miles north of town.
B24298	224B	do	do	<.1	From a farm 2½ miles east of town.
B24299	224C	do	Wheat	.5	
B24300	225A	Choteau	Spring wheat	.5	1933 crop.
B24302	226A	do	do	.5	
B24303	227A	do	Marquis wheat	.5	From NW¼ sec. 14, T. 24, R. 3 W.
B24304	228A	Dutton	Spring wheat	1	Composite from 20 farms.
B24305	228B	do	Winter wheat	.5	
B24306	229A	do	do	.5	Composite from 6 farms.
B24307	229B	do	Spring wheat	.5	Composite from 10 farms.
B24308	229C	do	Ceres wheat	.5	From a farm 8 miles east of town.
B24309	229D	do	Marquis wheat	1	From SW¼ sec. 36, T. 25 N., R. 1 E.
B24310	230A	do	Spring wheat	.5	Composite from 20 (?) farms.
B24311	230B	do	Winter wheat	<.1	Composite from 4 farms.
B24312	231A	do	Spring wheat	1	Composite from 18 farms.
B24313	231B	do	Winter wheat	.5	Composite from 3 farms.
B24324	233A	Power	do	<.1	Composite from 4 farms.
B24325	233B	do	Spring wheat	1	Composite from 8 farms.
B24326	233C	do	Ceres wheat	<.1	From a farm 13 miles east of town.
B24327	234A	do	Spring wheat	.5	Composite from 7 farms.

TOOLE COUNTY, MONT.

B24373	251A	Shelby	Spring wheat	0.5	
B24374	251B	do	do	.5	From freight carload.
B24375	251C	do	Winter wheat	.5	
B24376	252A	Dunkirk	Spring wheat	1	

TABLE 1.—*Selenium content of wheat and wheat products*—Continued

TOOLE COUNTY, MONT.—Continued

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B24377	252B	Dunkirk	Spring wheat	0.5	Composite from 18 farms.
B24378	252C	do	Winter wheat	1	Composite from 2 farms.
B24379	253A	Devon	Spring wheat	1	Composite from 15 farms.
B24380	253B	do	Winter wheat	2	From a farm 6 miles north of town.
B24381	253C	do	No. 1 spring wheat	.5	From freight carload.
B24382	254A	do	do	1	Composite from 15 farms.
B24383	254B	do	do	1	
B24384	255A	Galata	Spring wheat	1	Composite from 7 farms.
B24385	256A	do	do		Composite from 3 farms.
B24386	256B	do	Winter wheat		
B24387	256C	do	Spring wheat	1	From freight carload.

VALLEY COUNTY, MONT.

B24484	299A	Hinsdale	Spring wheat	0.5	Composite from 19 farms.
B24485	299B	do	No. 2 spring wheat	.1	From freight carload.
B24487	300A	Glasgow	Flour	1	
B24488	300B	do	do	2	
B24489	300C	do	Bran	1	
B24490	300D	do	Middlings	2	
B24491	300E	do	Wheat	.5	1937 and 1938 crops.
B24492	300F	do	do	1	Do.
B24493	301A	do	No. 1 spring wheat	.5	1937 crop.
B24494	301B	do	Spring wheat	1	
B24495	301C	do	No. 1 spring wheat	4	
B24496	301D	do	do	.5	
B24497	301E	do	do	.2	
B24498	301F	do	Spring wheat	1	
B24499	301G	do	No. 2 spring wheat	1	
B24500	302A	do	Spring wheat	1	
B24508	304A	Nashua	do	.1	
B24509	304B	do	do	1	
B24510	304C	do	do	1	From freight carload.
B24511	304D	do	do	.5	Do.
B24512	305A	do	do	1	
B24513	306A	Frazer	do	1	Composite from 15 farms.
B24514	306B	do	Winter wheat	.5	
B24515	307A	do	Spring wheat	.5	Composite from 14 farms.
B24516	308A	Oswego	do	.2	From 1 farm.
B24517	309A	do	do	.1	Composite from 5 farms.

YELLOWSTONE COUNTY, MONT.

B24098	165A	Billings	Flour	0.2	
B24099	165B	do	do	.5	
B24100	165C	do	Mill-run shorts and bran	.2	
B24101	165D	do	Whole-wheat flour	.1	
B24102	165E	do	Flour	.2	
B24103	165F	do	do	<.1	
B24104	165G	do	do	.2	
B24105	165H	do	do	.1	
B24106	165I	do	do	.1	
B24107	165J	do	do	.2	
B24108	165K	do	Wheat	.2	
B24109	165L	do	do	.2	
B24110	165M	do	Winter wheat	.2	Representative of 80,000 bushels.
B24111	165N	do	Spring wheat	.1	Representative of 20,000 bushels.
B24115	166D	do	Winter wheat	.2	
B24116	166E	do	do	.2	1937 crop.
B24117	167A	do	do	.2	Composite from 21 farms
B24118	167B	do	Spring wheat	.2	Composite from 2 farms.
B24120	168A	do	Winter wheat	.1	From a farm 21 miles south of town.
B24121	169A	do	Spring wheat	.2	
B24122	169B	do	Winter wheat	.2	

TABLE 1.—*Selenium content of wheat and wheat products*—Continued

BOYD COUNTY, NEBR.

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B23516	13A	W½SW¼ sec. 8, T. 33 N., R. 9 W.	Ripe wheat heads	6	Gathered in field.
B23517	14A	Anoka	Wheat	1	
B23608A	40D	Lynch	Durum wheat	2	Representative of all wheat handled by elevator.
B24716	374A	Bristow	Ceres wheat	1	
B24717	374B	do	Winter wheat	1	
B24721	375A	Lynch	Marquis wheat	2	
B24722	375B	do	Spring and winter wheat.	2	
B24723	375C	do	Marquis wheat	7	
B24725	375E	do	Durum wheat	2	

DAWES COUNTY, NEBR.

B23690	71A	Crawford	Wheat	1	From sec. 11, T. 32 N., R. 52 W.
B23691	72A	do	do	2	
B23692	72B	do	Ceres wheat	1	
B23693	72C	do	Marquis wheat	.5	
B23696	73A	do	Ceres wheat	.2	From a freight carload.
B23697	74A	Whitney	Winter wheat	.5	
B23698	74B	do	Ceres wheat	1	
B23699	74C	do	Marquis wheat	.5	
B23700	75A	do	Wheat	3	From 1¼ miles northwest of town; irrigated.
B23701	76A	do	Ceres wheat	3	From a farm 4 miles north of town.
B23703	77A	Sec. 18, T. 33 N., R. 50 W.	Wheat	1	Irrigated.
B23705	78A	SW¼ sec. 7, T. 33 N., R. 50 W.	Chieftain wheat	3	
B23710	80C	SW¼ sec. 8, T. 33 N., R. 50 W.	Wheat	3	Gathered in field.
B23711	81A	SW¼ sec. 9, T. 33 N., R. 50 W.	Rustproof wheat	2	
B23717	84A	SW¼ sec. 19, T. 33 N., R. 50 W.	Spring wheat	3	Irrigated.
B23719	86A	Chadron	Flour	.2	
B23720	86B	do	do	.5	
B23721	86C	do	do	.2	
B23722	86D	do	Graham flour	.2	
B23723	87A	do	Spring wheat	.5	
B23724	87B	do	Winter wheat	.2	
B23725	87C	do	Winter and spring wheat.	.5	
B23726	87D	do	No. 3 wheat	.5	1/3 1937 spring and 2/3 1938 winter.
B23727	87E	do	No. 2 wheat	<.1	Do.
B23728	88A	do	Wheat samples	.5	Composite of elevator test samples.
B23729	88B	do	Winter wheat	.5	
B23730	88C	do	Ceres wheat	.5	
B23732	88E	do	Durum wheat	1	

FURNAS COUNTY, NEBR.

B23489	2A	Beaver City	Wheat	0.5	Composite from 2 elevators.

HARLAN COUNTY, NEBR.

B23488	1A	Alma	Wheat	<0.1	Composite from 2 elevators.

HITCHCOCK COUNTY, NEBR.

B23492	4A	Trenton	Wheat	1	Composite from 2 elevators.

TABLE 1.—*Selenium content of wheat and wheat products*—Continued

KNOX COUNTY, NEBR.

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B23501	7A	Niobrara	Wheat	2	1937 crop.
B23504	8A	Sec. 20, T. 23 N., R. 7 W.	Ripe wheat heads	8	Gathered in field.
B23507	8D	do	Wheat	10	1937 crop, from same field as 8A.
B23699	39A	Verdel	do	3	
B24727	376A	Niobrara	Spring wheat	1	
B24728	376B	do	Winter wheat	3	

REDWILLOW COUNTY, NEBR.

B23491	3A	McCook	Wheat	0.5	From 2 elevators.

SHERIDAN COUNTY, NEBR.

B23738	90A	Hay Springs	Ceres wheat	0.5	
B23739	90B	do	Marquis wheat	.5	
B23740	90C	do	Winter wheat	.2	
B23741	91A	do	Ceres wheat	.2	
B23742	91B	do	Winter wheat	<.1	
B23743	91C	do	Durum wheat	.2	
B23744	92A	do	Winter wheat	.2	
B23745	92B	do	Ceres and Marquis wheat.	.2	
B23746	93A	Rushville	Flour	4	
B23747	93B	do	Shorts	4	
B23748	93C	do	Bran	6	
B23749	93D	do	Wheat	4	Cleaned and blended for milling.
B23750	93E	do	do	10	
B23751	93F	do	Winter wheat	.5	
B23752	94A	do	do	.5	
B23753	94B	do	Ceres and Marquis wheat.	.2	
B23754	95A	Clinton	Winter wheat	.2	
B23755	95B	do	Spring wheat	<.1	
B23758	96A	Gordon	Winter wheat	<.1	
B23759	96B	do	Spring wheat	.2	
B23761	96D	do	Wheat	<.1	Composite of elevator test samples.
B23762	96E	do	Amber and durum wheat.	.5	
B23763	95A	do	Winter wheat	<.1	
B23764	96B	do	Spring wheat	.2	
B23767	97A	do	Winter wheat	<.1	
B23768	97B	do	Spring wheat	.5	
B23769	98A	do	Shorts	.2	
B23770	98B	do	Flour	<.1	
B23771	98C	do	do	<.1	
B23772	98D	do	Bran	.5	
B23773	98E	do	Blended wheat	<.1	

SIOUX COUNTY, NEBR.

B23801	114A	NE. corner sec. 5, T. 34 N., R. 53 W.	Wheat heads	4	Gathered in field.

BURLEIGH COUNTY, N. DAK.

B24654	303A	Bismarck	Spring wheat	0.5	

MOUNTRAIL COUNTY, N. DAK.

B24596	345A	White Earth	Spring wheat	1	Composite from 3 farms.
B24597	346A	do	do	1	From a farm 6 miles north of town.
B24598	347A	Ross	do	1	
B24600	348A	do	do	.5	Composite from 8 farms.

TABLE 1.—*Selenium content of wheat and wheat products*—Continued

MOUNTRAIL COUNTY, N. DAK.—Continued

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B24603	349A	Stanley	Spring wheat	0.3	Composite from 10 farms.
B24606	349D	do	do	.5	From a freight carload.
B24607	350A	do	do	.5	Composite from 8 farms.
B24610	351A	Palermo	Ceres wheat	[illegible]	Composite from 3 farms.
B24611	351B	do	Durum wheat	1	From a farm 3 miles north of town.
B24612	352A	Blaisdell	Spring wheat	.5	From a farm 2 miles south and another 5 miles south of town.
B24613	353A	Tagus	Ceres wheat	1	Composite from 5 farms.

WARD COUNTY, N. DAK.

B24614	354A	Berthold	Spring wheat	0.2	Composite from 7 farms.
B24618	355A	do	do	.2	Composite from 18 farms.
B24619	355B	do	Durum wheat	1	
B24622	356A	Lonetree	Spring wheat	.2	Composite from 6 farms.
B24623	357A	Deslacs	do	.5	Composite from 8 farms.
B24626	358A	Minot	do	.2	Composite from 5 farms.
B24627	358B	do	Durum wheat	.5	
B24631	359A	do	Flour	.5	
B24632	359B	do	do	.2	
B24633	359C	do	Middlings	<.1	
B24635	359D	do	Bran	.2	
B24635	359E	do	Flour	.5	
B24636	359F	do	Winter wheat	.2	
B24637	359G	do	Spring wheat	1	
B24638	360A	do	do	.5	
B24639	360B	do	do	.5	From Bottineau County, N. Dak.
B24640	360C	do	Lamfords spring wheat.	3	From Chinook, Mont.
B24641	360D	do	Winter wheat	.2	From Belt, Mont.
B24642	360E	do	do	.5	From Fort Benton, Mont
B24643	360F	do	Spring wheat	.2	From Gifford, Mont.
B24644	360G	do	do	.5	
B24645	361A	do	Flour middlings	.2	
B24646	361B	do	Bran	.2	
B24647	361C	do	Flour	.5	
B24648	361D	do	do	.5	
B24649	361E	do	Wheat	.2	50 percent 1937 and 50 percent 1938 crop.
B24650	361F	do	Spring wheat	.2	
B24651	361G	do	do	.2	Composite samples from cleaner.
B24652	361H	do	Flour	.5	
B24653	362A	do	Ceres wheat	.5	From sec. 31, T. 152 N., R. 82 W.

WILLIAMS COUNTY, N. DAK.

B24561	330A	Trenton	Spring wheat	0.5	Composite from 5 farms.
B24562	330B	do	do	.5	Composite from 6 farms, 1936 crop.
B24563	331A	Williston	do	.2	From a freight carload shipped from Chinook, Mont.
B24564	331B	do	do	.5	Do.
B24565	331C	do	Wheat	.5	From a freight carload shipped from Fort Benton, Mont.
B24566	331D	do	Winter wheat	.5	Do.
B24567	331E	do	do	.5	Do.
B24568	331F	do	do	.5	From a freight carload shipped from Carter, Mont.
B24569	331G	do	Spring wheat	1	Composite from 10 farms within a radius of 35 miles of town.
B24570	332A	do	do	.5	Composite from 20 farms.
B24571	332B	do	Ceres wheat	1	From freight carload.
B24572	332C	do	Marquis wheat	<.1	
B24573	333A	do	Spring wheat	.2	
B24574	333B	do	do	.5	

TABLE 1.—*Selenium content of wheat and wheat products*—Continued

WILLIAMS COUNTY, N. DAK.—Continued

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B24576	334A	Williston	Spring wheat	1	Composite from 8 farms.
B24577	335A	Epping	do	.5	Composite from 9 farms.
B24578	335B	do	48 pounds spring wheat	.5	From freight carload.
B24579	336A	do	Spring wheat	1	Composite from 16 farms.
B24580	337A	Wheelock	do	.5	Composite from 12 farms.
B24581	338A	do	do	.5	Composite from 15 farms.
B24583	339A	Ray	do	2	
B24584	340A	do	Ceres wheat	1	Composite from 7 farms.
B24585	340B	do	Durum wheat	1	Composite from 2 farms.
B24586	341A	do	No. 4 spring wheat	1	From freight carload.
B24587	341B	do	No. 3 spring wheat	2	From a farm 12 miles north of town.
B24589	341D	do	Spring wheat	1	From a farm 13 miles north of town.
B24591	342A	Tioga	do	1	
B24592	343A	do	do	1	Composite from 16 farms.
B24593	344A	do	do	1	Composite from 6 farms.
B24594	344B	do	do	2	From freight carload.
		BRULE COUNTY, S. DAK.			
B24699	370A	Chamberlain	Ceres wheat	1	
B24700	370B	do	Durum wheat	3	
		BUTTE COUNTY, S. DAK.			
B23816	119A	Vale	Marquis wheat	<0.1	Irrigated.
B23847	119B	do	do	1	
B23850	120A	SW¼ sec. 18, T. 8 N., R. 6 E.	Spring wheat	1	Gathered in field.
B23853	121A	Newell	Wheat	.2	Mixed irrigated and dry land.
B23854	121B	do	Marquis wheat	.2	Irrigated.
B23856	122A	do	Ceres wheat	1	Mixed irrigated and dry land.
B23857	122B	do	Spring wheat	1	
B23858	122C	do	Ceres wheat	.5	Irrigated.
B23863	122H	do	Winter wheat	1	Do.
B23866	123A	Sec. 16, T. 9 N., R. 5 E.	Spring wheat	.2	From truck in field; irrigated.
B23867	124A	Nisland	do	2	
B23868	124B	do	do	.5	Irrigated.
B23871	124E	do	Wheat	.5	Refuse wheat in weed seeds.
B23872	124F	do	do	1	Composite of elevator test samples.
B23874	126A	Belle Fourche	do	.2	
B23875	126B	do	Spring wheat	.5	Composite of 22 elevator test samples.
B23876	126C	do	Winter wheat	.5	Composite of 15 elevator test samples.
B23877	126D	do	Winter wheat and rye mixed	1	Do.
B23878	126E	do	Winter wheat	.5	Blended.
B23879	126F	do	do	.5	From Beulah, Wyo.
B23882	126I	do	Spring wheat	.5	Blended.
B23883	126J	do	Ceres wheat	1	From 8 miles south of Belle Fourche.
B23884	126K	do	Spring wheat	.2	From irrigated farms 5–7 miles east of Belle Fourche.
B23885	126L	do	do	.5	From farm 9 miles west of town.
B23886	126M	do	do	.5	50 percent from Nebraska and 50 percent from Belle Fourche.
B23887	126N	do	Winter wheat	.2	From Devils Tower, Wyo.
B23888	126P	do	Spring wheat	.5	Wyoming, Montana, and South Dakota mixed.
B23889	126Q	do	Winter wheat	<.1	Wyoming and South Dakota mixed.
B23890	126R	do	Spring wheat	.2	

TABLE 1.—*Selenium content of wheat and wheat products*—Continued

CUSTER COUNTY, S. DAK.

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B23682	69A	Buffalo Gap	Hard winter wheat	1	From a farm 6 miles east of town.
B23683	69B	do	Hard spring wheat	.5	From farms 1-5 miles south of town.

FALL RIVER COUNTY, S. DAK.

B23674	68A	Hot Springs	Hard spring wheat	2	
B23675	68B	do	Wheat	2	
B23676	68C	do	Wheat, hard spring	.2	
B23677	68D	do	Graham flour	2	
B23678	68E	do	Bran and shorts	3	
B23679	68F	do	Bran	1	
B23680	68G	do	Hard winter wheat	.2	
B23687	70B	Oelrichs	do	1	
B23688	70C	do	do	1	
B23774	99A	Sec. 5, T. 10 S., R. 9 E.	Spring wheat	4	Owner reports no alkali trouble.
B23775	100A	Sec. 15, T. 10 S., R. 7 E.	Wheat	.5	Taken from truck in field.
B23776	101A	Sec. 12, T. 10 S., R. 6 E.	do	4	1937 crop, from bin on farm.
B23777	102A	NE. corner sec. 12, T. 10 S., R. 6 E.	Ripe wheat heads	2	Gathered in field.
B23778	103A	Sec. 34, T. 9 S., R. 6 E.	Ceres wheat	4	From bin on farm.
B23781	106A	Sec. 19, T. 9 S., R. 4 E.	Spring wheat	1	Do.
B23784	107A	Edgemont	Winter wheat	.5	
B23785	107B	do	Spring wheat	15	
B23787	108A	NW¼ sec. 21, T. 9 S., R. 3 W.	Wheat	3	From combine in field.
B23788	109A	Sec. 17, T. 10 S., R. 3 E.	Spring wheat	<.1	From bin on farm.
B23789	110A	Sec. 1, T. 11 S., R. 3 E.	Wheat	7	From freight carload.
B23790	111A	Sec. 32, T. 11 S., R. 4 E.	Spring wheat	1	
B23799	113A	Ardmore	do	10	

GREGORY COUNTY, S. DAK.

B23522	16A	SE¼ of SE¼ sec. 19, T. 100 N., R. 72 W.	Wheat	8	1937 crop.
B23523	16B	do	Wheat heads	6	From same field as 16A, 1938 crop.
B23525	17B	SW¼ sec. 21, T. 100 N., R. 72 W.	Wheat	25	Grown on same field as corn sample B23524 (table 4, p. 36).
B23531	20B	do	do	2	
B23596	38A	Dallas	do	4	
B23600	43A	Bonesteel	do	3	
B23603	44A	Burke	do	.5	Composite from 2 elevators.
B23614	45C	do	do	1	
B24704	372A	Gregory	Ceres wheat	2	
B24705	372B	do	Durum wheat	2	
B24706	372C	do	do	1	
B24708	372E	do	Winter wheat	.5	From farm 1 mile southwest of town.
B24710	373A	do	do	.2	
B24711	373B	do	Spring and winter wheat	1	
B24712	373C	do	Durum wheat	5	

HAAKON COUNTY, S. DAK.

B23648	57A	Philip	Wheat	1	
B23649	58A	Midland	do	7	

TABLE 1.—*Selenium content of wheat and wheat products*—Continued

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
			HUGHES COUNTY, S. DAK.		
				P. p. m.	
B24655	364A	Pierre	Durum wheat	8	
B24656	364B	do	Ceres wheat	1	
B24657	364C	do	do	7	
B24658	364D	do	Wheat	5	From north of Vivian.
			JACKSON COUNTY, S. DAK.		
B23646	50A	Kadoka	Wheat	0.5	Composite from 11 farms 10–45 miles south of town.
B23647	50B	do	do	<.1	Composite from 7 farms 10–30 miles south of town.
B23650	59A	Cottonwood	Wheat from elevator	.5	Composite from farms 1–25 miles north of town.
B23645	55A	Belvidere	Wheat	3	
			JONES COUNTY, S. DAK.		
B23639	53A	Draper	Wheat	5	
B23640	53A	Murdo	do	2	
B23642	53C	do	do	1	
B23643	54A	Okaton	do	2	
			LYMAN COUNTY, S. DAK.		
B23614	46A	Reliance	Wheat	2	
B23616	47A	Kennebec	do	4	
B23617	47B	do	do	2	
B23618	48A	Presho	do	4	Composite from 2 elevators.
B23622	45E	do	Flour	.5	From Belle Fourche.
B23623	49A	Vivian	Wheat	3	
B23540	24C	Sec. 8, 9, 17, 20, T. 108 N., R. 78 W.	do	7	1937 crop composite.
B23541	24D	SE¼ sec. 8, T. 108 N., R. 78 W.	Ripe wheat heads	20	Gathered in field; only grain analyzed.
B23578	30A	NE¼ sec. 21, T. 108 N., R. 79 W.	do	4	Do.
B23580	31A	0.1 mile north of E¼ corner sec. 10, T. 108 N., R. 79 W.	do	4	Do.
B23581	32A	N½ sec. 22, T. 107 N., R. 79 W.	Wheat	8	1937 crop. From bin on farm. Owner reported that eggs do not hatch when chickens are fed on this grain.
B23582	32B	do	Ripe wheat heads	15	Gathered in field; only grain analyzed.
B23584	34A	NE corner sec. 20, T. 107 N., R. 79 W.	do	1	Do.
B23585	35A	SE¼ sec. 29, T. 107 N., R. 79 W.	Wheat	5	From combine in field.
B24667	366A	Presho	Ceres wheat	5	
B24668	366B	do	do	5	
B24669	366C	do	do	5	From farm 8 miles southwest of town.
B24670	366D	do	No. 2 durum wheat	8	
B24671	366E	do	do	5	
B24672	366F	do	No. 1 durum wheat	4	
B24673	366G	do	Durum wheat	7	
B24676	367A	do	Ceres wheat	5	
B24677	367B	do	do	3	
B24678	367C	do	Durum wheat	3	
B24679	367D	do	do	8	From farm 3 miles east of town.
B24680	367E	do	do	6	
B24681	367F	do	do	5	
B24685	368A	Kennebec	do	5	
B24686	368B	do	do	4	
B24687	368C	do	do	5	
B24688	368D	do	do	6	
B24689	368E	do	do	5	

TABLE 1.—*Selenium content of wheat and wheat products*—Continued

LYMAN COUNTY, S. DAK.—Continued

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B24691	369B	Reliance	Durum and Ceres wheat.	2	Composite of elevator test samples.
B24692	369C	do	Durum wheat	2	From farm 6 miles northwest of town.
B24693	369D	do	Ceres wheat	3	Composite from 3 farms.
B24694	369E	do	Durum wheat	1	Composite from 6 farms.
B24696	369G	do	Ceres wheat	.5	
B24698	369I	do	Wheat	2	Mixed black bean and durum.

MEADE COUNTY, S. DAK.

B23643	117A	SW¼ sec. 1, T. 7 N., R. 5 E.	Spring wheat	2	Composite of irrigated dryland wheat.

PENNINGTON COUNTY, S. DAK.

B23651	60A	Quinn	Wheat	1	
B23654	62A	Wall	do	1	
B23655	63A	Wasta	do	.2	
B23656	64A	New Underwood	do	.2	
B23657	65A	Rapid City	First-grade flour	.5	
B23658	65B	do	Flour	.2	
B23659	65C	do	do	.2	
B23661	65E	do	Graham flour	.2	
B23662	66A	do	Wheat	1	From Buffalo Gap freight carload.
B23663	66B	do	do	.2	From Newcastle, Wyo., freight carload.
B23664	66C	do	do	.2	
B23665	66D	do	do	.5	1937 crop.
B23668	66G	do	do	.2	From a freight carload from northwestern Nebraska.
B23669	67A	do	do	1	From 3 miles northwest of Box Elder.

STANLEY COUNTY, S. DAK.

B23543	25B	SE¼ sec. 31, T. 109 N., R. 79 W.	Ripe wheat heads	5	Gathered in field; only grain analyzed.
B23574	28A	SE corner NE¼ sec. 23, T. 109 N., R. 79 W.	do	3	Do.
B23624	50A	Fort Pierre	Wheat	1	
B23625	51A	NE¼ sec. 34, T. 109 N., R. 79 W.	do	4	From truck at elevator.
B24660	365A	Fort Pierre	Durum wheat	5	
B24661	365B	do	Ceres wheat	.2	
B24662	365C	do	No. 40 Ceres wheat	4	
B24663	365D	do	Durum wheat	5	
B24666	365G	do	Wheat	2	Composite of elevator test samples.

TRIPP COUNTY, S. DAK.

B23586	36A	Winner	Wheat	3	Composite from 3 elevators.
B23587	36B	do	do	2	Composite from 2 elevators; 1937 crop.
B23592	37A	Colome	do	4	1937 crop.

BIG HORN COUNTY, WYO.

B24015	154B	Basin	Spring wheat	0.2	Irrigated, 1937 crop.
B24018	155A	Greybull	Wheat	.5	Do.

TABLE 1.—*Selenium content of wheat and wheat products*—Continued

CAMPBELL COUNTY, WYO.

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B23959	144A	Gillette	Spring wheat	0.5	
B23960	144B	do	Winter wheat	.2	
B23962	144D	do	do	<.1	From freight carload.
B23975	146A	do	Spring wheat	.2	Do.
B23976	146B	do	Winter wheat	1	
B23977	146C	do	Spring wheat	.2	
B23980	147A	do	do	.5	Composite sample from 5 farms; 1937 crop.
B23981	147B	do	Winter wheat	.5	Composite sample from 6 farms; 1937 crop.
B23982	147C	do	Spring wheat	<.1	

CONVERSE COUNTY, WYO.

B23914	136A	Douglas	Wheat	0.5	1937 crop.
B23922	137A	do	Ceres wheat	.2	
B23927	138A	do	Wheat	.5	
B23928	138B	do	Spring wheat	<.1	
B23929	138C	do	Winter wheat	.2	

CROOK COUNTY, WYO.

B23597	130A	Sec. 21, T. 50 N., R. 67 W.	Spring wheat	0.5	From bin on farm.
B23898	131A	Moorcroft	do	<.1	1937 crop.
B23899	131B	do	do	<.1	
B23903	131F	do	do	.2	

JOHNSON COUNTY, WYO.

B23895	151A	Buffalo	Wheat	0.5	1937 crop.

NATRONA COUNTY, WYO.

B23938	140E	Casper	Wheat	<0.1	From Lusk.
B23939	140F	do	do	<.1	1937 crop; from Riverton.
B23942	141A	do	do	.2	From Buffalo.
B23948	142C	do	do	1	1937 crop.
B23950	143A	Edgerton	Spring wheat	.5	Do.

NIOBRARA COUNTY, WYO.

B23802	115A	Lusk	Ceres wheat	<0.1	
B23803	115B	do	Wheat	.5	Composite of spring and winter wheat.
B23911	134A	18 miles south of Weston County line on R. 60.	Ripe wheat heads	3	Gathered in field; only grain analyzed.

SHERIDAN COUNTY, WYO.

B23903	149A	Arvada	Spring wheat	0.5	
B23904	149B	do	Winter wheat	.5	
B23905	150A	Clearmont	Spring wheat	.2	Irrigated.
B23906	150B	do	Winter wheat	.6	1937 crop.
B23907	150C	do	do	.5	
B24022	156A	Sheridan	Flour	.5	
B24023	156B	do	do	.5	
B24024	156C	do	do	.2	
B24025	156D	do	do	.5	
B24026	156E	do	do	.2	
B24028	156G	do	do	.2	
B24029	156H	do	do	.2	
B24030	156I	do	Whole-wheat flour	.2	
B24031	156J	do	Mill shorts	.5	
B24032	156K	do	Mill bran	1	

TABLE 1.—*Selenium content of wheat and wheat products*—Continued

SHERIDAN COUNTY, WYO.—Continued

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B24033	156L	Sheridan	Wheat	0.5	Baker's blend, ready for grinding.
B24034	156M	do	Shorts	.5	
B24035	156N	do	Germ flakes	.5	
B24036	156P	do	Family flour wheat	<.1	
B24037	156Q	do	Germ flakes	.5	
B24038	156R	do	Mixed bran and shorts.	1	
B24039	157A	do	Winter wheat	.2	1937 crop.
B24040	157B	do	Spring wheat	.5	Do.
B24041	157C	do	Winter wheat	.2	
B24045	157G	do	do	1	Composite of 12 freight carloads from Hardin, Mont.
B24046	157H	do	do	.2	Composite of 11 freight carloads from Arvada.
B24047	157I	do	do	.2	Composite of 12 freight carloads from Lodge Grass, Mont.
B24048	157J	do	Spring wheat	1	Composite of 2 freight carloads from Wyarno.

WASHAKIE COUNTY, WYO.

B24004	153A	Worland	Winter wheat	0.5	Irrigated.
B24006	153C	do	Spring wheat	.5	1937 crop.
B24009	153F	do	Wheat	.2	1937 crop; irrigated.

WESTON COUNTY, WYO.

B23833	116A	Newcastle	Flour	0.5	
B23834	116B	do	Best flour	.2	
B23835	116C	do	Flour	.2	
B23836	116D	do	do	<.1	
B23837	116E	do	Graham flour	.5	
B23838	116F	do	Bran	.2	
B23839	116G	do	Shorts	.5	
B23840	116H	do	Hard winter wheat	.5	
B23841	116I	do	Winter wheat	.2	From a freight carload from Gillette.
B23842	116J	do	Spring wheat	.5	1937 crop.
B23910	133A	Sec. 24, T. 42 N., R. 60 W.	Ripe wheat heads	.2	Gathered from stock; only grain analyzed.
B23960	132A	Upton	Winter wheat	<.1	From farm 11 miles north of town.

TABLE 2.—*Selenium content of wheat and wheat products secured through the facilities of the Food and Drug Administration*

COLORADO

Sample No.	Place of collection	Material	Selenium as Se
			P. p. m.
B23832	Strasburg	No. 1 mixed wheat	<0.1
B24746	do	No. 2 dark hard winter wheat	1
B24747	do	do	1
B24884	La Junta	No. 1 hard winter wheat (irrigated)	1
B24888	Rocky Ford	Hard winter wheat	1
B24894	Ordway	Wheat (irrigated)	1

KANSAS

B23811	Wallace	No. 4 dark hard winter wheat	0.5
B23812	Page City	No. 3 dark hard winter wheat	1
B23813	Grainfield	No. 2 dark hard winter wheat	.5
B23814	Hays	No. 4 dark hard winter wheat	.2

TABLE 2.—*Selenium content of wheat and wheat products secured through the facilities of the Food and Drug Administration*—Continued

KANSAS—Continued

Sample No.	Place of collection	Material	Selenium as Se
			P. p. m.
B24745	Wakeeney	No. 2 dark hard winter wheat	1
B24748	Hays	do	2
B24749	Wheeler	No. 3 dark hard winter wheat	.5
B24750	Grainfield	No. 2 dark hard winter wheat	1
B24751	do	do	.5
B24752	Hays	No. 3 dark hard winter wheat	1
B24753	do	No. 1 dark hard winter wheat	1
B24890	do	do	.5

MINNESOTA

B24852	Warren	No. 2 dark northern spring wheat	0.2
B24854	Donaldson	No. 3 hard amber durum wheat	.2
B24858	Warren	No. 2 dark northern spring wheat	.2
B24865	do	No. 3 dark northern spring wheat	.2
B24879	Crookston	No. 2 hard amber durum wheat	.5

MONTANA

B25217	Havre	No. 1 dark northern spring wheat	1
B25218	Cut Bank	No. 2 dark northern spring wheat	.5
B25219	Conrad	No. 1 dark northern spring wheat	1
B25220	Great Falls	do	.1
B25221	Shelby	No. 2 dark northern spring wheat	1
B25222	Dutton	No. 3 dark northern spring wheat	1
B25251	Chouteau	Wheat	1
B25252	Fort Benton	do	1
B25253	Lewistown	do	.2

NEBRASKA

B23817	Harrison	Wheat	0.2
B23818	Crawford	No. 1 dark hard winter wheat	1
B23819	Whitney	do	.1
B23823	Chadron	No. 2 hard winter wheat	2
B23828	Bristow	No. 2 dark hard winter wheat	2
B23829	Lynch	No. 2 durum wheat	3
B23830	Niobrara	No. 3 dark hard spring wheat	5
B23831	Fordyce	do	.1
B24740	Hay Springs	Hard amber durum wheat	1
B24844	Crawford	No. 4 northern spring wheat	.2
B24845	Chadron	No. 3 spring wheat	1
B24847	Crawford	No. 1 hard amber durum wheat	.2
B25202	Whitney	No. 2 dark northern wheat	1
B25203	Harrison	do	.5
B25204	Chadron	do	.5
B25205	Crawford	No. 5 dark northern wheat	1
B25206	Harrison	No. 2 mixed winter and spring wheat	1
B25207	Whitney	No. 4 dark northern wheat	.5
B25208	Chadron	No. 3 dark northern spring wheat	1
B25209	Crawford	No. 1 dark northern winter wheat	.2
B25211	Bristow	No. 3 hard white winter wheat	5
B25212	Lynch	do	1
B25213	do	do	3
B25214	Niobrara	No. 3 dark hard winter wheat	5
B25215	do	No. 5 dark hard winter wheat	1
B25216	Bristow	No. 4 dark northern winter wheat	1

NORTH DAKOTA

B24848	Minot	No. 5 dark northern spring wheat	0.5
B24851	Grand Forks	No. 1 hard amber durum wheat	.2
B24853	do	No. 2 hard amber durum wheat	.2
B24856	do	No. 1 hard amber durum wheat	.2
B24860	Grafton	No. 2 dark northern spring wheat	.1
B24861	Grand Forks	No. 2 hard amber durum wheat	.2
B24863	West Fargo	do	.2
B24864	Fargo	No. 3 dark northern spring wheat	.5
B24866	Minot	No. 5 dark northern spring wheat	.2

TABLE 2.—*Selenium content of wheat and wheat products secured through the facilities of the Food and Drug Administration*—Continued

NORTH DAKOTA—Continued

Sample No.	Place of collection	Material	Selenium as Se
			P. p. m.
B24867	Minot	No. 4 dark northern spring wheat	0.5
B24868	Fargo	do	.2
B24875	Minot	No. 4 hard dark spring wheat	.2
B24876	do	No. 4 dark northern spring wheat	.5

SOUTH DAKOTA

B23820	Ardmore	No. 2 dark hard spring wheat	12
B23821	Provo	Wheat	2
B23822	Hoppner	do	3
B23824	Winner	No. 3 dark hard spring wheat	3
B23825	do	do	3
B23826	Dixon	No. 1 dark hard winter wheat	3
B23827	Gregory	Wheat	.2
B24741	Presho	No. 2 hard amber durum wheat	4
B24842	Winner	No. 3 durum wheat	2
B24846	Gregory	do	2
B24849	Winner	No. 4 amber durum wheat	2
B24850	do	No. 3 dark northern spring wheat	2
B24855	do	No. 4 dark northern spring wheat	2
B24857	do	No. 3 hard amber durum wheat	.2
B24859	do	No. 3 dark northern spring wheat	3
B24862	do	No. 4 dark northern spring wheat	3
B24869	Reliance	No. 2 dark northern spring wheat	2
B24870	Chamberlain	No. 4 dark northern spring wheat	1
B24871	Vivian	No. 2 dark northern spring wheat	4
B24872	Presho	No. 5, 89-percent hard red, 11-percent white winter wheat.	.5
B24873	Kennebec	No. 5 dark northern spring wheat	4
B24874	Presho	No. 1 hard amber durum wheat	3
B24877	Reliance	No. 2 hard amber durum wheat	2
B24878	Chamberlain	No. 4 dark northern spring wheat	2
B24880	Reliance	No. 2 dark northern spring wheat	2
B24881	do	No. 5 dark northern spring wheat	2
B24882	do	do	2
B24883	Chamberlain	No. 4 dark northern spring wheat	3
B25296	Rapid City	Wheat	.5
B25297	do	Flour	.5
B25298	do	do	1
B25299	do	Wheat bran	.5
B25300	do	Wheat middlings	.5
B25301	do	Red dog (wheat flour)	.5
B25302	Gregory	Wheat	4
B25303	do	Flour	4
B25304	do	do	5
B25305	do	Bran	5
B25306	do	Middlings	4
B25307	do	Wheat screenings	5

WYOMING

B23815	Torrington	Wheat	0.1
B23816	Douglas	do	.1
B24742	Gillette	No. 2 dark northern spring wheat	
B24743	do	No. 2 mixed wheat	.5
B24744	Wheatland	No. 1 dark northern spring wheat	.2
B24843	Laramie	No. 2 dark hard winter wheat	.1
B25210	Torrington	No. 3 dark northern spring wheat	.5

TABLE 3.—*Selenium content of wheat secured through courtesy of the General Mills Co., Inc.*

Sample No.	Source of sample	Representative sample from—	Selenium as Se
			P. p. m.
B25175	La Junta, Otero County, Colo.	Elevator bin	1
B25176	Lamar, Prowers County, Colo.	do	.5
B25177	Las Animas, Bent County, Colo.	do	.5
B25178	Strasburg, Arapahoe County, Colo.	Carload	.2
B25179	Avondale, Pueblo County, Colo.	Elevator bin	1
B25180	Holly, Prowers County, Colo.	do	.5
B25181	Sharon Springs, Wallace County, Kans.	do	2
B25182	Wallace, Wallace County, Kans.	do	.5
B25183	Wakeeney, Trego County, Kans.	do	.2
B25184	Hays, Ellis County, Kans.	do	.2
B25185	Park, Gove County, Kans.	do	.2
B25201	Crookston, Polk County, Minn.	Carload	.5
B25191	Miles City, Custer County, Mont.	do	.2
B25192	Great Falls, Cascade County, Mont.	do	<.1
B25193	do	do	<.1
B25194	Dutton, Teton County, Mont.	do	1
B25195	do	do	1
B25196	Conrad, Pondera County, Mont.	do	1
B25197	Choteau, Teton County, Mont.	do	1
B25198	Shelby, Toole County, Mont.	do	.2
B25199	Havre, Hill County, Mont.	do	.5
B25200	Poplar, Roosevelt County, Mont.	do	.5
B25186	Chadron, Dawes County, Nebr.	Elevator bin	<.1
B25187	do	Carload	.5
B25188	Whitney, Dawes County, Nebr.	do	1
B25189	Winner, Tripp County, S. Dak.	do	3
B25190	Fort Laramie, Goshen County, Wyo.	do	<.1

The samples in table 1 represent various quantities of wheat, from a shock to many thousand bushels. Further, they represent wheat products ranging from bran to flour and breakfast food. Therefore, not only must the content of a sample be taken into consideration but also the amount and kind of material it represents. The information presented under the column headed "Remarks" is intended to assist in judging the sample. Where no information is given concerning a sample of wheat. the sample represents the grain in an elevator bin. Taking the samples as a whole, 83 percent of them contained 1 p. p. m. or less, 92.5 percent contained less than 4 p. p. m., and 7.5 percent contained 4 p. p. m. or more of selenium. There were seven samples that contained 10 p. p. m. or more of selenium, and the maximum found was 25 p. p. m.

The wheat samples given in table 2 represent primarily elevator bins and freight carloads. The samples are similar in selenium content to those in table 1. About 75 percent of the samples contained 1 p. p. m. or less, 90 percent contained less than 4 p. p. m., and 10 percent contained 4 p. p. m. or more of selenium.

The samples in table 3 are representative of commercial lots of grain from elevator bins and carload shipments. The selenium content of the samples in general is comparable to that of the samples in tables 1 and 2, but none of the samples in table 3 contain more than 3 p. p. m. of selenium.

Tables 1, 2, and 3 include data on nearly 1,000 samples of wheat and wheat products. The great majority of them cannot be considered toxic. Because there is little in the literature that permits an appraisal of the selenium intake tolerated by human beings without injury, all references to toxicity in this bulletin relate to experimental or domestic animals. Certainly those samples that contain 4 p. p. m. or more, if they constitute the whole diet, would be toxic to white rats.

In Colorado there is comparatively little wheat grown on seleniferous soil, yet all the samples that were examined (tables 1, 2, and 3) contained selenium. The maximum found was 3 p. p. m.

The seleniferous soils of Kansas are derived from the Pierre, Niobrara, and Benton formations. These Cretaceous sediments outcrop in a series that increases in age from west to east. They are not exposed uniformly. The soils overlaying them are sometimes derived from the nonseleniferous Ogallala formation or from loess material. The toxic areas are primarily in Gove, Graham, Lane, Norton, Phillips, Rooks, Scott, and Trego Counties.

Although there is considerable seleniferous soil in Kansas, no great amount of it is devoted to wheat. This assertion is based on the field work in making a selenium survey of the State (*5*) and on field observations made in connection with the collection of the wheat samples given in table 1. The eroded areas adjacent to streams are the most toxic, but such rough terrain is not suited for wheat farming. No exact data are available on the amount of seleniferous land devoted to wheat.

The wheat samples examined (tables 1, 2, and 3) were in general low in selenium content, that is, they contained less than 4 p. p. m. However, three samples, B23450 from Graham County, B23429 from Trego County, and B23388 from Wallace County, contained 5, 5, and 4 p. p. m., respectively. The first two of these samples were collected directly from the fields. There are probably fields scattered throughout the seleniferous area that produce some wheat toxic to domestic animals.

The samples collected in western Minnesota (table 2) were obtained because the places of collection receive wheat from the States to the west. No significant amount of selenium was found in the few samples analyzed.

There are large areas in Montana that produce some toxic vegetation due to selenium (*55*). In general, the soils are low in selenium; this is especially noticeable if they are compared with the seleniferous soils of South Dakota. Soils occur, however, throughout the area that are much higher in selenium than the average. There are several geologic factors that contribute to the erratic distribution of selenium in the soils of Montana. Although certain Cretaceous formations of the area always contain selenium, the amount varies greatly within the profiles and from one location to another. This is further complicated by the frequent occurrence of a mantle of debris from the Keewatin ice sheet, Rocky Mountain glaciers, and outwash from the mountains. The soil may be formed from the underlying formations, the mantle of debris, or from a mixture of the two. Large areas of seleniferous soil are devoted to the production of wheat. There is a large region in which seleniferous soils occur in the northern part of the State from the Rocky Mountains to the eastern border. A smaller region includes Big Horn and portions of the adjoining counties. The areas were covered by the collection of over 400 samples of wheat (tables 1, 2, and 3).

The wheat samples represent amounts ranging from a truckload to a composite sample of 41 farms, from an elevator bin sample to a carload lot. Although they represent from small amounts to very large amounts, the selenium content was low, with an average of 0.5

p. p. m. and a maximum of 4 p. p. m. The wheat products prepared in the area were also low in selenium content.

There are small amounts of toxic grain grown in Montana, but the amount is so small that it is readily reduced to a low selenium content by mixture with other grain in the local elevators. A few samples collected from fields have been reported to contain over 4 p. p. m. (*55*).

In portions of northern Nebraska the seleniferous Cretaceous sediments outcrop. Some of the soils derived from these sediments are high in selenium. Previous surveys have shown the areas to produce toxic vegetation (*4*, *5*). The characteristic chronic selenium poisoning of stock occurs also. The wheat survey included these seleniferous areas. A total of 108 samples was collected.

There were 13 samples that contained 4 or more p. p. m. of selenium and 2 of them contained 10 p. p. m. Some of these toxic samples are of special interest. Sample B23504, from Knox County (table 1), was gathered in the field and was found to contain 8 p. p. m. The farmer had some of the 1937 crop from this field in a bin and a sample of it, B23507, was found to contain 10 p. p. m. This bears out the observations of farmers that certain fields invariably produce toxic grain. Other examples will be noted elsewhere in this bulletin.

The selenium content of samples B23746 to B23750, inclusive (table 1), collected at a roller mill in Sheridan County, was: Flour 4 p. p. m., shorts 4 p. p. m., bran 6 p. p. m., wheat cleaned and blended for milling 4 p. p. m., and wheat 10 p. p. m., respectively. Any one of these samples, if used as the diet for rats, would produce characteristic symptoms of chronic selenium poisoning (*35*). The wheat sample containing 10 p. p. m. would produce characteristic signs of chronic selenium poisoning in hogs (*44*) and as a laying ration for hens would prevent the hatching of their eggs (*41*).

No previous survey has been made for selenium in North Dakota. *Astragalus bisulcatus* and *A. pectinatus* were observed while driving through the northwest portion of the State. These species have been infallible in marking seleniferous areas in previous surveys, notably in the survey of a similar area in Montana (*55*). Wheat samples were therefore collected in Burleigh, Mountrail, Ward, and Williams Counties. It was found that all except one of the samples contained easily detectable amounts of selenium. However, the selenium content of the samples was low, the maximum for the area being only 2 p. p. m.

In the western part of South Dakota there are extensive areas of soil developed from the Pierre and Niobrara as well as from other formations of Cretaceous age. Certain portions of these formations are relatively high in selenium, as are the soils developed on them (*4*, *5*, *32*, *34*). Both chronic and acute poisoning of animals is well recognized in these areas.

Nearly 200 samples of wheat and wheat products were collected in the areas known to be seleniferous (*4*, *5*, *34*). There are considerably more samples for the amount of wheat grown than were collected in Montana. The known toxicity of some of the grain in this area made it desirable to have numerous samples. Of these samples 43 percent were 1 p. p. m. or less, 69 percent were less than 4 p. p. m., and 31 percent were 4 p. p. m. or over. The maximum selenium content was 25 p. p. m., in sample B23525 from Gregory County (table 1). The average of all samples collected in the State

was 2.8 p. p. m. Some of the samples of high selenium content were collected from fields whereas others represent elevator bin samples and carload lots. Nearly one-third of the samples (not one-third of the wheat) contained sufficient selenium to make them toxic to rats. The grain represented by many of the samples would be readily toxic to stock, and if used as a laying ration would prevent the hatching of eggs. In fact, the farmer in Lyman County who furnished sample B23581, table 1, reported that eggs from chickens fed on the grain would not hatch. The sample contained 8 p. p. m. of selenium.

Samples B25302 to B25307 (table 2) from a roller mill in Gregory are of special interest. All of the samples collected contain sufficient selenium to be toxic to rats. Samples of wheat, flour, and middlings contain 4 p. p. m. and samples of flour, bran, and wheat screenings contain 5 p. p. m. of selenium.

Beath and his associates have reported seleniferous areas and stock losses from toxic vegetation in certain portions of Wyoming (*1*, *24*). Byers has reported seleniferous soils and toxic vegetation collected on reconnaissance surveys in the State (*4*, *5*). Eighty samples of wheat and wheat products were collected in these areas (tables 1, 2, and 3). The selenium content of the samples was low. Eleven samples contained less than 0.1 p. p. m. and all contained 1 p. p. m. or less, except one which contained 3 p. p. m. There have been reported cases of selenium poisoning in the State from toxic grain (*24*).

SELENIUM AS A NORMAL CONSTITUENT OF WHEAT

Many soils outside of the seleniferous areas have been examined for selenium. Selenium has been found in all soil samples that have been carefully examined. It follows, then, that vegetation growing on these soils should also contain some selenium and that if a sufficiently large sample were used a positive test for it would result.

The analysis of wheat reported in tables 1 to 3 was made on a 10-gm. sample, which permitted the detection of as little as 0.2 p. p. m. Some of the samples collected in the region in which seleniferous soils may occur did not give a test for selenium and are noted in the tables as containing less than 0.1 p. p. m. Three such samples were selected for reexamination, and 100 gm. was taken for analysis. In all three samples, B24150, B24201, and B25186, selenium was detected, the amounts being 0.02, 0.02, and 0.05 p. p. m., respectively.

Wheat samples from humid areas were also examined. Twenty-five samples of wheat grown in Delaware, Illinois, Indiana, Maryland, Michigan, Missouri, North Carolina, New Jersey, New York, Ohio, Pennsylvania, Tennessee, and West Virginia were examined for selenium. No selenium was detected when a 10-gm. sample was used. Three 85-gm. samples, one each from Illinois, Missouri, and Tennessee, were reexamined and were found to contain 0.02, 0.02, and 0.03 p. p. m. of selenium, respectively.

Robinson (*42*) examined wheat from Argentina, Australia, Canada, Hungary, Mexico, South Africa, and Spain, in addition to domestic samples. He found selenium in all of the samples examined. The authors agree with Robinson that it is improbable that any field-grown wheat is entirely free from selenium, because when carefully examined, wheat has always been found to contain selenium. The

mere presence of selenium in wheat must not be viewed with alarm, as it is probably a normal constituent. The presence of selenium in grain becomes a problem only when it occurs in sufficient quantities to be injurious to animals.

SELENIUM CONTENT OF BARLEY, CORN, OATS, AND RYE

Although the survey was made primarily for wheat, it seemed advisable to collect other grain when available. Therefore, nearly 300 samples of barley, corn, oats, and rye were collected. The data are given in table 4.

TABLE 4.—*Selenium content of barley, corn, oats, and rye*

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
			BENT COUNTY, COLO.	*P. p. m.*	
B23370	5A	Las Animas	Barley	1	1937 crop; irrigated.
			CHEYENNE COUNTY, COLO.		
B23384	9B	Kit Carson	Corn	0.5	
			CROWLEY COUNTY, COLO.		
B23360	2B	Ordway	Oats	1	Irrigated.
B23362	2D	do	Popcorn	1	Do.
			KIOWA COUNTY, COLO.		
B23382	8B	Eads	Corn	0.1	
			OTERO COUNTY, COLO.		
B23356	1D	Fowler	Barley	0.5	Irrigated.
B23367	4B	La Junta	Trebi barley	.5	Do.
B23369	4D	6 miles west of La Junta.	Corn	1	Do.
			PROWERS COUNTY, COLO.		
B23373	6A	Lamar	Barley	1	Composite of irrigated and dry land grain.
B23375	6C	do	Red oats	.5	Irrigated.
			LOGAN COUNTY, KANS.		
B23413	23A	SW corner sec. 17, T. 14 S., R. 37 W.	Ripe barley heads	3	Gathered in field.
B23415	24A	W¼ corner sec. 18, T. 14 S., R. 36 W.	do	1	Do.
			WALLACE COUNTY, KANS.		
B23409	21B	SW corner sec. 18, T. 14 S., R. 38 W.	Ripe barley heads	1	Gathered in field 100 yards from B23408 (table 1).
B23389	12B	Weskan	Corn	1	
B23390	12C	do	Milo	1	

TABLE 4.—*Selenium content of barley, corn, oats, and rye*—Continued

BIG HORN COUNTY, MONT.

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B24057	159F	Lodge Grass	Oats	0.2	1937 crop.
B24058	159G	do	Barley	.5	Do.
B24085	160G	Hardin	Oats	.5	Do.
B24086	160H	do	Barley	.2	1937 crop; irrigated.
B24075	161H	do	do	.5	Mixture of 1937–38 crops; irrigated.
B24076	161I	do	Oats	.2	Irrigated.
B24084	162G	do	Barley	.5	Do.

BLAINE COUNTY MONT.

B24442	235B	Chinook	Oats	1	1937 crop.

CARTER COUNTY, MONT.

B23895	129A	SE¼ sec. 10, T. 9 S., R. 60 E.	Barley heads	2	From stack in field.

CASCADE COUNTY, MONT.

B24269	216H	Great Falls	Barley	0.2	1937 crop; from Fairfield irrigation project, Teton County.
B24282	218K	do	do	.1	Do.
B24283	218L	do	Oats	.2	Do.
B24289	220C	Vaughn	do	.5	1937 crop; irrigated.

CHOUTEAU COUNTY, MONT.

B21109	202C	Fort Benton	Rye	1	

FERGUS COUNTY, MONT.

B24146	180C	Winifred	Rye	0.1	From a freight carload.

GLACIER COUNTY, MONT.

B24368	248C	Cut Bank	Oats	0.1	1937 crop; from farms 3-8 miles west of town; irrigated.
B24369	248D	do	Barley	.2	1937 crop from north of Valier.

HILL COUNTY, MONT.

B24427	280B	Havre	Oats	0.2	1937 crop.
B24428	280C	do	do	.5	Do.
B24429	280D	do	Barley	.5	Do.
B24430	280E	do	Rye	1	Do.
B24434	281C	do	Oats	.2	Do.
B24435	281D	do	Barley	.2	Do.
B24438	282C	do	Rye	.2	Do.

PETROLEUM COUNTY, MONT.

B24124	171A	Winnett	Oats	1	

TABLE 4.—*Selenium content of barley, corn, oats, and rye*—Continued

PHILLIPS COUNTY, MONT.

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B24458	201B	Dodson	Oats	0.2	1937 crop; irrigated.
B24465	203F	Malta	do	.2	
B24470	204D	do	do	.1	
B24471	204E	do	Barley	.2	1937 crop.

PONDERA COUNTY, MONT.

B24338	230C	Conrad	Barley	2	1937 crop.
B24339	230D	do	Oats	1	Do.

SHERIDAN COUNTY, MONT.

B24545	322B	Plentywood	Oats	0.1	Grown 6 miles southeast of town.

TETON COUNTY, MONT.

B24291	222A	Fairfield	Barley	0.2	1937 crop; irrigated.
B24292	222B	do	Oats	.1	Do.

YELLOWSTONE COUNTY, MONT.

B24090	164E	Billings	Fall rye	0.1	
B24091	164F	do	Dent corn	.5	
B24092	164G	do	Semi-dent corn	.1	
B24112	166A	do	Barley	.2	Mixed dry and irrigated grain.
B24113	166B	do	Oats	1	1937 crop.
B24119	167C	do	Rye	.2	

BOYD COUNTY, NEBR.

B23510	10A	Sec. 21, T. 34 N., R. 10 W.	Oats	0.5	
B23511	11A	E½ of NE¼ sec. 1, T. 33 N., R. 10 W.	do	7	Gathered on a diagonal across an 80-acre field.
B23512	11B	SE. cor. sec. 36, T. 34 N., R. 10 W.	Barley heads	1	Gathered in field across from B23511.
B23514	12A	W½ of W½ sec. 8, T. N., R. 9 W. (2 miles south of NW. corner sec.).	do	12	Gathered in field. Soil contained 2 p. p. m. Se.
B23515	12B	do	Ripe oat heads	15	Gathered in field.
B23518	14B	Anoka	Barley	.5	Composite of 1937 crop from several farms.
B23520	15A	NE¼ sec. 3, T. 34 N., R. 13 W.	Oats	15	Gathered within 100 feet of shale containing 4 p. p. m. Se.
B23521	15B	do	Barley heads	6	Grown on raw Pierre shaley soil 0.2 mile south of B23520.
B23601	40A	Lynch	Barley	4	Grown on sec. 17, T. 33 N., R. 9 W.
B23602	40B	do	do	7	Do.
B23603	40C	do	Rye	4	Grown on sec. 19, T. 33 N., R. 9 W.
B23603B	40E	do	do	1	Composite of elevator test samples of all rye bought.
B23604	41A	Anoka	do	.5	
B24718	374C	Bristow	Oats	2	
B24719	374D	do	Barley	1	
B24720	374E	do	Fall rye	1	
B24721	375D	Lynch	Oats	2	
B24723	375F	do	Barley	3	

TABLE 4.—*Selenium content of barley, corn, oats, and rye*—Continued

CEDAR COUNTY, NEBR.

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B23495	5A	NE cor. sec. 11, T. 31 N., R. 1 E.	Ripe oats	1	Gathered in field.
B23496	5B	do	Barley	.5	Do.
B23497	6A	Fordyce	do	1	Mixture of 1937 and 1938 crops.
B23498	6B	do	Rye	.5	1937 crop.
B23499	6C	do	Oats	1	Do.
B23500	6D	do	Corn	1	Do.
B24731	377A	do	Barley	.2	
B24732	377B	do	Oats	.5	
B24733	377C	do	Fall rye	4	

DAWES COUNTY, NEBR.

B23694	72D	Crawford	Rye	0.5	
B23695	72E	do	Barley	.2	1937 crop.
B23704	77B	Sec. 18, T. 33 N., R. 50 W.	Oats	3	Collected 30 feet from B23703 (table 1); irrigated.
B23706	79A	SW¼ sec. 7, T. 33 N., R. 50 W.	do	3	1937 crop.
B23708	80A	SW¼ sec. 8, T. 33 N., R. 50 W.	Oats from shock	1	
B23709	80B	do	Barley from same shock as B23708.	1	
B23713	83A	SE¼ sec. 20, T. 33 N., R. 50 W.	Oats	.1	1937 crop; irrigated.
B23714	83B	do	Barley	1	Do.
B23715	83C	do	Corn	2	Do.
B23731	88D	Chadron	Rye	1	

FURNESS COUNTY, NEBR.

B23490	2B	Beaver City	Corn	0.5	1937 crop.

KNOX COUNTY, NEBR.

B23502	7B	Niobrara	Rye	1	1937 crop.
B23503	7C	do	Corn	1	Do.
B23505	8B	Sec. 20, T. 33 N., R. 7 W.	Oats	5	1937 crop; 40-acre field north of B23504 (table 1, p. 18).
B23508	8C	do	Corn	2	Do.
B23509	9A	0.2 mile north of SE corner sec. 18, T. 33 N., R. 8 W.	Ripe oats	.2	Gathered within 20 feet of soil containing 1.5 p. p. m. Se.
B23600	39B	Verdel	Barley from elevator.	2	
B24729	376C	Niobrara	Fall rye	3	
B24730	376D	do	Barley	1	

SHERIDAN COUNTY, NEBR.

B23756	95C	Clinton	Barley	0.1	
B23757	95D	do	Oats	.2	
B23760	96C	Gordon	Barley	.2	
B23765	96CX	do	Rye	1	
B23766	96DX	do	Barley	.1	

MOUNTRAIL COUNTY, N. DAK.

B24599	347B	Ross	Fall rye	2	
B24601	348B	do	do	1	
B24604	349B	Stanley	do	1	
B24605	349C	do	Oats	.2	
B24608	350B	do	Fall rye	.5	
B24609	350C	do	Oats	1	

TABLE 4.—*Selenium content of barley, corn, oats, and rye*—Continued

WARD COUNTY, N. DAK.

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B24615	354B	Berthold	Oats	0.2	
B24616	354C	do	Fall rye	.2	
B24617	354D	do	Barley	.2	
B24620	355C	do	Fall rye	.5	
B24624	357B	Deslacs	do	.5	
B24625	357C	do	Barley	2	
B24628	358C	Minot	Fall rye	.5	
B24629	358D	do	Oats	.5	
B24630	358E	do	Barley	.2	

WILLIAMS COUNTY, S. DAK.

B24588	341C	Ray	Oats	0.5	
B24590	341E	do	Barley	1	

BRULE COUNTY, S. DAK.

B24701	370C	Chamberlain	Fall rye	3	
B24702	370D	do	Barley	1	

BUTTE COUNTY, S. DAK.

B23845	118A	SW¼ sec. 30, T. 8 N., R. 6 E.	Oats	0.2	Irrigated.
B23848	119C	Vale	Barley	.5	Composite from irrigated and dry-land farms.
B23849	119D	do	Oats	.5	Do.
B23851	120B	SW¼ sec. 18, T. 8 N., R. 6 E.	do	.5	Irrigated.
B23852	120C	do	Barley	.2	Do.
B23855	121C	Newell	do	.2	1937 crop.
B23859	122D	do	do	.5	Irrigated.
B23864	122I	do	do	.5	Do.
B23865	122J	do	Corn	.2	Do.
B23869	124C	Nisland	Barley and wheat	.5	
B23870	124D	do	Oats	.5	Do.
B23880	126G	Belle Fourche	Rye	.5	1937 crop.
B23881	126H	do	Barley	.2	

CUSTER COUNTY, S. DAK.

B23684	69C	Buffalo Gap	Rye	2	From irrigated farms 5–7 milseast of Belle Fourche.
B23685	69D	do	Barley	2	

FALL RIVER COUNTY, S. DAK.

B23681	68H	Hot Springs	Barley	0.2	1937 crop.
B23686	70A	Oelrichs	do	1	Do.
B23689	70D	do	Rye	1	Do.
B23779	104A	N½ sec. 2, T. 10 S., R. 5 E.	Barley	1	
B23780	105A	Sec. 32, T. 95, R. 5 E.	Oats	1	From bin on farm.
B23782	106B	Sec. 19, T. 95, R. 5 E.	Barley	.2	Do.
B23783	100C	do	Rye	.5	Do.
B23786	107C	Edgemont	Barley	.5	1937 crop.
B23791	111B	Sec. 32, T. 11 S., R. 4 E.	do	1	Do.
B23800	113B	Ardmore	do	5	Do.

GREGORY COUNTY, S. DAK.

B23524	17A	SW¼ sec. 21, T. 100 N., R. 72 W.	Corn	30	1937 crop; from 160-acre field. Farmer will not feed this grain.
B23526	18A	NE¼ sec. 20, T. 100 N., R. 72 W.	Oats	12	1937 crop.

TABLE 4.—*Selenium content of barley, corn, oats, and rye*—Continued

GREGORY COUNTY, S. DAK.—Continued

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B23527	18B	NE¼ sec. 20, T. 100 N., R. 72 W.	Rye	25	1938 crop, from field in which B23526 was grown in 1937.
B23528	19A	E½ of NW¼ sec. 30, T. 100 N., R. 72 W.	Corn	2	Average field sample of 1937 crop.
B23529	19B	do	do	6	1937 crop; from eroded portion of field.
B23529A	19C	do	do	6	1938 crop; field average. From same field as B23526.
B23529B	19D	do	do	10	Eroded area.
B23530	20A	Gregory	do	1	1937 crop; from 30 miles north to 30 miles south of town.
B23532	20C	do	Barley	5	
B23533	21A	NE¼ of SE¼ sec. 28, T. 99 N., R. 72 W.	do	2	
B23535	22A	NE corner SW¼ sec. 28, T. 99 N., R. 72 W.	Ripe barley heads	2	Gathered in field.
B23597	38B	Dallas	Barley	1	
B23598	38C	do	Corn	2	Composite of samples of 1937 crop; from north and south of town.
B23605	42A	Fairfax	Barley	1	
B23607	43B	Bonesteel	do	1	Composite from several farms.
B23609	44B	Burke	do	.5	Composite from 2 elevators.
B23610	44C	do	Rye	2	
B23611	44D	do	Oats	.1	
B23612	45A	Gregory	Barley	3	Do.
B23613	45B	do	Rye	2	Elevator
B24707	372D	do	Fall rye	1	
B24709	372F	do	Barley	2	
B24713	373D	do	do	.5	
B24714	373E	do	Oats	.5	From 2 miles east of town.
B24715	373F	do	Fall rye	.2	

HUGHES COUNTY, S. DAK.

B24359	361E	Pierre	Barley	3	From north of Vivian.

JONES COUNTY, S. DAK.

B23641	53B	Murdo	Barley	5	
B23644	54B	Okaton	do	1	

LYMAN COUNTY, S. DAK.

B23538	21A	SW¼ sec. 17, T. 108 N., R. 78 W.	Oats	5	1937 crop; from bin on farm.
B23539	24B	NE¼ sec. 17, T. 108 N., R. 78 W.	do	3	From bin on farm.
B23615	46B	Reliance	Barley	1	
B23619	48B	Presho	do	3	Composite from 2 elevators.
B23620	48C	do	do	5	Composite from farms north of town.
B23621	48D	do	Rye	7	Composite of samples from 1937 and 1938 crops.
B24674	366H	do	Barley	3	
B24675	366I	do	do	2	Grown 5 miles northwest of town.
B24682	367G	do	do	8	
B24683	367H	do	Oats	5	Grown 12 miles northwest of town.
B24684	367I	do	Corn	5	1937 crop.
B24690	369A	Reliance	Barley	.5	Composite from elevator test.
B24695	369F	do	Fall rye	2	From freight carload.
B24697	369H	do	Barley	2	From farm 4 miles northeast of town.

TABLE 4.—*Selenium content of barley, corn, oats, and rye*—Continued

MEADE COUNTY, S. DAK.

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B23844	117B	SW¼ sec. 1, T. 7 N., R. 5 E.	Barley	1	Irrigated.

PENNINGTON COUNTY, S. DAK.

B23660	65D	Rapid City	Rye flour	1	Rye from near Oelrichs.
B23666	66E	do	Rye	2	1937 crop; grown near Oelrichs.
B23667	66F	do	Barley	4	1937 crop; grown near Presho.
B23670	67B	do	do	4	1937 crop; grown near Chamberlain.
B23671	67C	do	Oats	1	From 12 miles northwest of town.
B23673	67E	do	Rye	.1	1937 crop; grown near Sturgis.

STANLEY COUNTY, S. DAK.

B23542	25A	SE¼ sec. 31, T. 109 N., R. 79 W.	Ripe oats	8	Gathered in field.
B23621A	50B	Fort Pierre	Barley	4	Composite from elevator test samples.
B23621B	50C	do	Rye	1	Do.
B24064	365E	do	Barley	11	Grown in Jones County.

TRIPP COUNTY, S. DAK.

B23588	36C	Winner	Barley	2	Composite from 3 elevators.
B23589	36D	do	do	3	1937 crop; composite from 2 elevators.
B23590	36E	do	Rye	2	From 2 elevators.
B23591	36F	do	Corn	2	Grown north of town.
B23593	37B	Colome	Barley	3	Composite of samples from north of town.
B23594	37C	do	Rye	2	Do.
B23595	37D	do	Corn	.1	Composite of samples from south of town.

BIG HORN COUNTY, WYO.

B24014	154A	Basin	Barley	0.2	
B24019	155B	Greybull	do	.5	1937 crop; irrigated.
B24020	155C	do	Oats	.5	Do.

CAMPBELL COUNTY, WYO.

B23961	144C	Gillette	Corn	0.2	1937 crop.
B23967	145A	do	do	.2	Do.
B23971	145E	do	Seed corn	.2	From Billings, Mont.
B23973	145H	do	Oats	.1	1937 crop.
B23978	146D	do	Barley	.5	Do.
B23979	146E	do	Cracked corn	.2	
B23983	147D	do	Barley	.2	Do.
B23984	147E	do	Oats	.5	Do.
B23985	147F	do	Corn	.2	Do.

CONVERSE COUNTY, WYO.

B23915	136B	Douglas	Barley	0.2	1937 crop.
B23916	136C	do	Oats	.2	
B23917	136D	do	do	.1	Do.
B23918	136E	do	Spring rye	.1	Do.
B23919	136F	do	Winter rye	.2	Do.

TABLE 4.—*Selenium content of barley, corn, oats, and rye*—Continued

CONVERSE COUNTY, WYO.—Continued

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B23920	136G	Douglas	Dent corn	1	1937 crop.
B23921	136H	do	Gehu corn	.1	Do.
B23923	137B	do	Barley	.2	Do.
B23924	137C	do	Oats	.5	Do.
B23925	137D	do	Dent corn	.5	Do.
B23926	137E	do	Fall rye	.1	Do.
B23930	138D	do	Barley	.1	Do.
B23931	138E	do	Oats	.2	Do.
		CROOK COUNTY, WYO.			
B23900	131C	Moorcroft	Barley	0.2	1937 crop.
B23901	131D	do	Rye	.1	
B23904	131G	do	Oats	.1	
B23905	131H	do	Corn	.5	Do.
		JOHNSON COUNTY, WYO.			
B23999	151B	Buffalo	Barley	0.2	1937 crop.
B24000	151C	do	Oats	.2	Do.
		NATRONA COUNTY, WYO.			
B23934	140A	Casper	Barley	0.2	Grown near Douglas crop.
B23935	140B	do	Barley	.1	1937 crop.
B23937	140D	do	Rye	.5	
B23940	140G	do	Oats	.1	1937 crop. Grown near Sheridan.
B23943	141B	do	do	.5	From 3 miles west of town.
B23944	141C	do	Barley	.2	From Kaycee; 1937 crop.
B23945	141D	do	Fall rye	.2	1937 crop.
B23946	142A	do	Barley	.1	1937 crop; irrigated.
B23947	142B	do	Oats	.5	Do.
B23949	142D	do	do	.2	
B23951	143B	Edgerton	do	.5	1937 crop.
B23952	143C	do	Corn	.5	Do.
		NIOBRARA COUNTY, WYO.			
B23804	115C	Lusk	Fall rye	0.2	1937 crop.
B23805	115D	do	Barley	.5	Do.
B23806	115E	do	Oats	.1	Do.
B23807	115F	do	Corn	.2	Do.
B23912	135A	2 miles south of Red Bird on U. S. Route 85.	Wheat heads	.5	From stack in field.
B23913	135B	do	Rye heads	.5	Do.
		SHERIDAN COUNTY, WYO.			
B24042	157D	Sheridan	Barley	0.5	1937 crop.
B24043	157E	do	Oats	.2	Do.
B24044	157F	do	Rye	.1	Do.
		WASHAKIE COUNTY, WYO.			
B24005	153B	Worland	Barley	0.5	Irrigated.
B24007	153D	do	Oats	.2	1937 crop; irrigated.
B24008	153E	do	Barley	.2	Do.
		WESTON COUNTY, WYO.			
B23908	132C	Upton	Barley	0.5	1937 crop; from Moorcroft.
B23909	132D	do	Oats	1	Do.

The selenium content of 75 percent of the samples given in table 4 was 1 p. p. m. or less, 89 percent contained less than 4 p. p. m., and 11 percent contained 4 p. p. m. or more. The maximum found was 30 p. p. m. in a sample of corn.

The samples from Colorado were all of low selenium content, the maximum being only 1 p. p. m. Nearly all the samples were grown on irrigated land, which tends to keep the selenium content of plants lower than when grown without irrigation (*9*).

FIGURE 1.—A pig with the characteristic symptoms of chronic selenium poisoning, loss of hair and deformed hoofs.

Few samples were available in Kansas and they were of relatively low selenium content. One sample contained 3 p. p. m. and the others 1 p. p. m. or less.

Of the 40 samples collected in Montana only 2 contained as much as 2 p. p. m. The low selenium content of the samples is in harmony with the data on wheat samples from the same areas.

Grains other than wheat were also found to contain sufficient selenium to be toxic to domestic animals in Nebraska. Nine of the forty-nine samples collected contained 4 p. p. m. or more of selenium. The maximum found was 15 p. p. m. in two samples of oats (B23515 and B23520). Barley, sample B23514, Boyd County, grown on a 40-acre field, contained 12 p. p. m. The adjoining 40 acres produced oats, sample B23515, containing 15 p. p. m. The soil collected at the junction of the fields contained 2 p. p. m. In another instance, oats, sample B23511, growing in one field, contained 7 p. p. m., and barley, sample B23512, growing in the adjoining field, contained but 1 p. p. m. A sample of wheat, B23504 (table 1), from Knox County, contained 8 p. p. m. It is of interest to note that a 40-acre field north of the field producing the wheat grew oats (B23505) with a selenium content of 5 p. p. m., and a 40-acre field northwest of the wheat grew corn (B23506) containing but 2 p. p. m. In this case the corn will be the good stock feed. Samples of three different grains were taken from the same shock in Dawes County. Oats B23708, barley B23709 (table 4), and wheat B23710 (table 1, p. 17) contained 1, 1, and 3 p. p. m. of selenium, respectively.

These examples bring out clearly the fact that even in a seleniferous area in which very toxic grain is grown there are fields that produce good grain as well as fields that produce toxic grain. The authors

have made surveys of many seleniferous areas and have always found that even the worst toxic areas are not uniformly seleniferous.

The selenium content of the barley, corn, oats, and rye of North Dakota was low, which is in agreement with the results obtained on wheat. All of the 17 samples contained readily detectable amounts of selenium, but only 2 contained as much as 2 p. p. m.

The seleniferous areas of South Dakota produce grain toxic to domestic animals. A sample of corn, B23524, from Gregory County, contained 30 p. p. m. of selenium. This grain, the 1937 crop from a 160-acre field, was not used for feed by the farmer. It has been stated previously that grain containing 10 p. p. m. will produce severe cases of chronic selenium poisoning in pigs (44). Pigs on this farm had lost hair and developed deformed hoofs, as shown in figure 1.

A field in 1937 produced a crop of oats, sample B23526, containing 12 p. p. m. of selenium, and was followed in 1938 by a crop of rye, sample B23527, that contained 25 p. p. m. This again is evidence that certain fields always produce toxic grain. Another sample of special interest is a composite of the elevator test samples of rye (B23621, Lyman County), from the 1937 and 1938 crops. This composite sample contained 7 p. p. m. of selenium. It seems very probable that some of this rye was of considerably higher selenium content.

The barley, corn, oats, and rye samples collected in Wyoming are very low in selenium. Only 2 of the 57 samples contained as much as 1 p. p. m.

SELENIUM CONTENT OF MISCELLANEOUS CROPS

During the field survey, samples of crops were collected other than barley, corn, oats, rye, and wheat. These are tabulated in table 5.

One of the important mustard-producing areas of the United States is located in Cascade, Pondera, Teton, and Toole Counties, Mont. Twenty-three samples of mustard seed grown in this area were examined for selenium. This plant of high sulfur content does not store any considerable amount of selenium in the seed. One of the samples examined contained 5 p. p. m. of selenium, the others 3 p. p. m. or less.

Of the 17 samples of beans examined, 1 contained 3 p. p. m., another 2 p. p. m., and the remainder 1 p. p. m. or less of selenium. The maximum selenium content found in the 18 samples of flaxseed was 5 p. p. m.

Ten samples of millet seed were examined for selenium and all contained 1 p. p. m. or less. Samples B23892 to B23894 were taken in a field of millet in Carter County, Mont. The soil contained 0.5 p. p. m. of selenium and the tops and roots of the millet growing in the soil were 0.5 and 0.4 p. p. m. of selenium, respectively. Gile and Lakin [3] have observed that 1 p. p. m. of selenium, as sodium selenate, in quartz sand resulted in "half injury" to the yield of millet, whereas the air-dried plant contained 500 p. p. m. of selenium. Sodium selenite proved even more toxic to millet, 0.3 p. p. m. being adequate to produce half injury in sand culture. The low selenium content of the millet samples collected is another confirmation of the fact that frequently very little of the selenium in the soil is absorbed by the crops grown upon it.

[3] See footnote 2, p. 4.

TABLE 5.—*Selenium content of miscellaneous crops*

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
BENT COUNTY, COLO.					
B23371	5B	Las Animas	Milo	*P. p. m.* 0.5	1937 crop; irrigated.
CHEYENNE COUNTY, COLO.					
B23385	10A	Cheyenne Wells	Milo	0.5	
B23383	9A	Kit Carson	do	1	
CROWLEY COUNTY, COLO.					
B23358	1F	20 miles north of Fowler.	Milo	0.5	
B23359	2A	Ordway	Pinto beans	3	Irrigated.
B23361	2C	do	Millet seed	1	Do.
B23363	2E	do	Cane	1	Do.
KIOWA COUNTY, COLO.					
B23381	8A	Eads	Milo	<0.1	
OTERO COUNTY, COLO.					
B23353	1A	Fowler	Hopi lima beans	1	Irrigated.
B23354	1B	do	Henderson bush lima beans.	.5	Do.
B23355	1C	North of Fowler	Pinto beans	2	
B23364	3A	Rocky Ford	Zinnia seeds	.5	
B23365	3B	do	Cantaloup seeds	.5	
B23368	4C	La Junta	Pinto beans	<.1	Grown 60 miles south of town.
PROWERS COUNTY, COLO.					
B23376	6D	Lamar	Alfalfa-stem meal	0.5	
B23377	6F	do	Alfalfa-leaf meal	.5	
LOGAN COUNTY, KANS.					
B23440	46B	Oakley (12 miles south of town).	Feterita	1	1937 crop.
B23441	46C	Oakley (8 miles southwest of town).	Red cane	<.1	
BIG HORN COUNTY, MONT.					
B21077	161J	Hardin	Great Northern beans	0.2	1937 crop.
CARTER COUNTY, MONT.					
B23892	128	SE¼ sec. 10, T. 9 S., R. 60 E.	Clay loam, 0–8 inches	0.5	
B23893	128A	do	Millet tops	.5	
B23894	128B	do	Millet roots	.4	
CASCADE COUNTY, MONT.					
B24270	217A	Great Falls	Yellow mustard seed	0.5	From Flowerce.
B24271	217B	do	Brown mustard seed	.5	From Portage.
B24272	218A	do	Crested wheatgrass seed	.5	1937 crop; from Fort Benton.
B24273	218B	do	Western wheatgrass seed	.5	1937 crop; from Glasgow.
B24274	218C	do	Yellow mustard seed	2	From Valier.

TABLE 5.—*Selenium content of miscellaneous crops*—Continued

CASCADE COUNTY, MONT.—Continued

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B24275	218D	Great Falls	Yellow mustard seed	1	From Brady.
B24276	218E	do	Brown mustard seed	.5	From Power.
B24277	218F	do	Millet seed	.5	1937 crop; from Billings.
B24278	218G	do	Hog millet seed	.5	Do.
B24279	218H	do	White sweetclover seed	.5	1937 crop; from Fairfield Beach.
B24280	218I	do	Alfalfa seed	.5	1937 crop; composite from Petroleum and Phillips Counties.
B24281	218J	do	Flaxseed	2	From Pondera County.
B24284	218M	do	Yellow mustard seed	1	From Phillips County.
		DANIELS COUNTY, MONT.			
B24532	317B	Scobey	Flaxseed	0.5	1937 crop.
		GLACIER COUNTY, MONT.			
B23992	349C	Cut Bank	Flaxseed	<0.1	1937 crop; grown 4 miles north of town.
		HILL COUNTY, MONT.			
B24431	280F	Havre	Flaxseed	0.2	1937 crop.
B24437	282B	do	Spelt	.5	Do.
		LIBERTY COUNTY, MONT.			
B24396	261D	Chester	Flaxseed	0.5	1937 crop.
		PHILLIPS COUNTY, MONT.			
B24465	293G	Malta	Flaxseed	0.2	1937 crop.
B24472	294E	do	do	.2	Do.
		PONDERA COUNTY, MONT.			
B24340	239E	Conrad	Flaxseed	1	1937 crop.
B24348	242D	Brady	Brown mustard seed	3	
B24349	242E	do	Yellow mustard seed	.5	Grown 13 miles east of town.
B24350	242F	do	do	2	Grown 2½ miles northwest of town.
B24351	242G	do	do	.5	Grown 3½ miles west of town.
B24352	242H	do	do	2	1937 crop; grown 18 miles east of town.
B24353	242I	do	do	2	1937 crop; grown 6½ miles west of town.
B24354	242J	do	Oriental mustard seed	2	1937 crop; grown 2 miles southeast of Conrad.
		TETON COUNTY, MONT.			
B24301	225B	Choteau	Flaxseed	0.5	
B24314	232A	Power	Yellow mustard seed	5	Grown 12 miles east of Conrad.
B24315	232B	do	do	1	Grown 12 miles east of Dutton.
B24316	232C	do	do	.5	Grown 10 miles west of Dutton.
B24317	232D	do	do	1	Grown near Conrad.
B24318	232E	do	do	.2	Grown on Fairfield beach; irrigated.
B24319	232F	do	Oriental mustard seed	1	Grown 6 miles northwest of town.

TABLE 5.—*Selenium content of miscellaneous crops*—Continued

TETON COUNTY, MONT.—Continued

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B24320	232G	Power	Oriental mustard seed	1	Grown near Sunburst.
B24321	232H	do	Brown mustard seed	.5	Grown near Dutton.
B24322	232I	do	Oriental mustard seed	2	Grown 6 miles northwest of Power.
B24323	232J	do	Yellow mustard seed	<.1	Grown near Pullman, Wash.
B24328	235A	2 miles north of Dutton on U. S. Route 91.	Flaxseed	<.1	

VALLEY COUNTY, MONT.

B24486	299C	Hinsdale	Flaxseed	0.2	1937 crop.
B24501	303A	Glasgow	Brown grass seed	<.1	Grown near Opheim.
B24502	303B	do	Western wheatgrass seed	.5	Irrigated.
B24503	303C	do	Crested wheatgrass seed	1	Grown 20 miles north of Hinsdale.
B24504	303D	do	do	.2	Grown near Opheim.
B24505	303E	do	White sweetclover seed	<.1	Grown 35 miles south of Malta, 1937 crop.
B24506	303F	do	Alfalfa seed	2	Grown 6 miles northeast of town, 1937 crop.
B24507	303G	do	Millet seed	<.1	Grown near Hinsdale, 1937 crop.

YELLOWSTONE COUNTY, MONT.

B24086	164A	Billings	Alfalfa seed	0.2	1937 crop.
B24087	164B	do	Crested wheatgrass seed	.2	Do.
B24088	164C	do	Yellow sweetclover seed	1	Do.
B24089	164D	do	Black Amber cane seed	.2	Do.
B24093	164A	do	Alfalfa seed	.1	Do.
B24094	164B	do	White sweetclover	1	
B24095	164C	do	Millet seed	<.1	Do.
B24096	164D	do	Crested wheatgrass seed	.2	Do.
B24097	164E	do	Western wheatgrass seed	.2	Do.
B24111	166C	do	Great Northern beans	.2	1937 crop; irrigated.

DAWES COUNTY, NEBR.

B23712	82A	NW¼ sec. 20, T. 33 N., R. 50 W.	Alfalfa seed	1	1937 crop; irrigated.
B23716	83D	SE¼ sec. 20, T. 33 N., R. 50 W.	Great Northern beans	.5	Do.
B23718	85A	Whitney	do	1	Do.

MOUNTRAIL COUNTY, N. DAK.

B24602	348C	Ross	Flaxseed	1	

WARD COUNTY, N. DAK.

B24621	355D	Berthold	Flaxseed	1	

WILLIAMS COUNTY, N. DAK.

B24575	333C	Williston	Flaxseed	1	Composite from 3 farms.
B24582	338B	Wheelock	do	1	
B24595	344C	Tioga	do	1	

BUTTE COUNTY, S. DAK.

B23860	122E	Newell	Millet seed	0.5	1937 crop.
B23861	122F	do	Spelt	.5	Irrigated.
B23862	122G	do	Sweetclover seed	.5	
B23873	125A	Belle Fourche	Sugar	<.1	1937 crop.

TABLE 5.—*Selenium content of miscellaneous crops*—Continued

FALL RIVER COUNTY, S. DAK.

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B23792	111C	Sec. 32, T. 11 S., R. 4 E.	Crested wheatgrass seed	7	1934 crop.
B23793	111D	do	Western wheatgrass	3	
B23794	111E	do	Amber sorgo	3	1931 crop.
B23795	111F	do	Tepary beans	.5	1937 crop.
B23798	111G	do	White beans	.5	Do.
		LYMAN COUNTY, S. DAK.			
B23575	29	Southeast corner sec. 9, T. 108 N., R. 79 W.	Boyd clay loam, 0–8 inches	2	
B23576	29A	do	Crested wheatgrass	2	Whole plant.
B23577	29B	do	do	7	Heads.
		STANLEY COUNTY, S. DAK.			
B24665	365F	Fort Pierre	Flaxseed	5	Grown 12 miles south of town.
		BIG HORN COUNTY, WYO.			
B24016	154C	Basin	Flaxseed	0.2	1937 crop; irrigated.
B24017	154D	do	Yellow sweetclover seed	.2	Do.
B24021	155D	Greybull	Great Northern beans	.2	Do.
		CAMPBELL COUNTY, WYO.			
B23963	144E	Gillette	Millet seed	0.5	
B23964	144F	do	Alfalfa seed	.5	1937 crop.
B23965	144G	do	Yellow sweetclover seed	1	Do.
B23966	144H	do	Mixed feed	.2	
B23968	145B	do	Alfalfa seed	.5	From Billings, Mont.
B23969	145C	do	Millet seed	.5	1937 crop.
B23970	145D	do	do	.5	From Billings, Mont.
B23972	145F	do	White sweetclover seed	.5	1937 crop; from Billings, Mont.
B23974	145G	do	Crested wheatgrass	<.1	Do.
B23986	147G	do	Millet seed	.5	1937 crop.
B23987	147H	do	Sudan grass seed	1	Do.
		CROOK COUNTY, WYO.			
B23902	131E	Moorcroft	Grains for chicken feed	0.5	
		NATRONA COUNTY, WYO.			
B23936	140C	Casper	Alfalfa-leaf meal	0.5	
B23941	146H	do	Calcium for feed mixture	.2	
		NIOBRARA COUNTY, WYO.			
B23803	115G	Lusk	Millet seed	<.1	1937 crop.
		WASHAKIE COUNTY, WYO.			
B24001	152A	Worland	Great Northern beans	0.5	1937 crop; irrigated.
B24002	152B	do	Giant Stringless beans	<.1	Do.
B24003	152C	do	Beans	.2	Do.
B24010	153G	do	Great Northern beans	.2	Do.
B24011	153H	do	Pinto beans	.2	Do.
B24012	153I	do	Yellow sweetclover seed	.5	Do.
B24013	153J	do	Alfalfa seed	<.1	Do.
		WESTON COUNTY, WYO.			
B23907	132B	Upton	Mixed grains for chicken feed	1	

Very few data are available on the amount of selenium taken up by crested wheatgrass, a dry-land range grass that is coming into wide use. Samples were taken from an experimental plot in Lyman County, S. Dak., which was used to study the culture of crested wheatgrass (fig. 2). The soil, sample B23575, contained 2 p. p. m. of selenium. A sample of the entire aerial portion of the plants, B23576, contained 2 p. p. m., and of the heads, B23577, contained 7 p. p. m. of selenium. Of the seven samples of crested wheatgrass

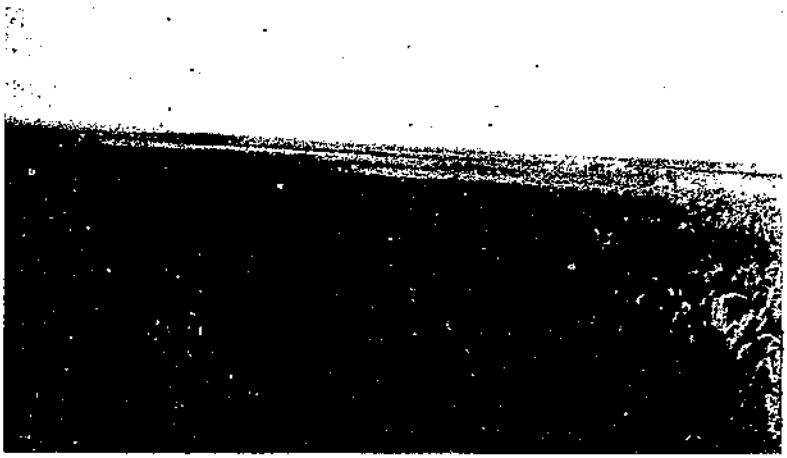

FIGURE 2.—Crested wheatgrass.

seed reported in table 5 one contained 7 p. p. m. of selenium and the others 1 p. p. m. or less.

A number of samples of other crops, such as alfalfa meal, milo, western wheatgrass, and cane seeds, were examined and found to be uniformly low.

SELENIUM IN CANADA

The Cretaceous shales have been found to contain significant quantities of selenium from northern New Mexico to the northernmost tier of counties in Montana (*4, 5, 9, 55*). Vegetation growing on soils derived from these Cretaceous sediments may be toxic from selenium. Some formations of the Cretaceous age occur in Alberta, Saskatchewan, and Manitoba Provinces of Canada. At the suggestion of Dr. L. E. Kirk, of Saskatchewan University, a reconnaissance survey of these areas was made in the spring of 1938 (*8*). J. S. Bolton, of the Dominion Agricultural Experiment Station at Swift Current, assisted in a considerable portion of the survey. His assistance was particularly valuable in the botanical identifications, which are a part of this text.

In making the survey, the geologic maps of the Canadian Bureau of Mines, Nos. 204A and 267A, were used as guides to the regions underlain by Cretaceous sediments. Map No. 204A shows extensive exposures of geologic formations of the Cretaceous period, which are identified under the names St. Mary's River, Fox Hills, Bearpaw, Belly River, Pakowki, and Milk River in eastern Alberta and western Saskatchewan. These correspond in a general way with the Fox

Hills, Bearpaw, Judith River, Eagle, and Telegraph formations of Montana and to various subdivisions of the Pierre formation in South Dakota and Nebraska (*4, 5*). No extensive outcrops of older Cretaceous formations corresponding to the Niobrara and other members of the Colorado shales are mapped. Map 267A shows a still larger region in which Cretaceous shales outcrop in the southern portion of Saskatchewan. This region includes a very small area in Manitoba also.

In the course of previous surveys it became clear that certain plants may be used as indicators of seleniferous areas because they are certain to contain selenium if any is present in available form. Among these plants, known to occur under the soil and climatic conditions in west central Canada, are *Astragalus bisulcatus* and *A. pectinatus*. The successful use of these plants in the survey of Montana made it desirable to time the survey in Canada so that these plants would be in bloom and readily observed.

With the geologic maps as guides to the general regions in which to work and *Astragalus bisulcatus* and *A. pectinatus* plants indicating the location of particular areas, nearly 300 samples of shale, soils, and vegetation were collected for selenium analysis. The data are given in table 6.

TABLE 6.—*Selenium content of soils, shales, and vegetation from Canada*

ALBERTA

Laboratory No.	Field No.	Location	Material	Selenium as Se—	
				Soil or shale	Vegetation
				P. p. m.	*P. p. m.*
B23068	17	47 miles west of Maple Creek, 1 mile west of Pashley.	Brown loam, 0-8 inches	0.5	..
B23069	17A	do	*Astragalus pectinatus*		640
B23070	18A	52 miles west of Maple Creek, 6 miles west of Pashley.	*Poa secunda* Presl (grass)		10
B23071	19	5 miles southwest of Medicine Hat, Route 3.	Brown loam 6-6½ feet	.3	...
B23072	19A	do	*Astragalus bisulcatus*		240
B23073	20	15 miles southwest of Medicine Hat, Route 3.	Brown clay loam, 0-8 inches	1	....
B23074	20A	16 miles southwest of Medicine Hat, Route 3.	*Astragalus pectinatus*		3,690
B23075	20B	do	Winter rye (immature heads)		8
B23076	21	½ mile east of Bow Island, Route 3.	Brown fine sandy loam, 0-8 inches.	.7	...
B23077	21A	do	*Astragalus pectinatus*		3,520
B23078	21B	do	Young wheat (4-5 inches)		80
B23079	22X	4½ miles northeast of Bow Island on road to Ferry.	Yellow sandy fossiliferous material. Foremost member of Belly River formation, 25 feet below top of breaks.	.5	...
B23080	22XA	do	*Astragalus bisulcatus*		25
B23081	22Y	do	Thinly laminated limestone 1 foot thick, 35 feet below top.	.3	.....
B23082	22YA	do	*Shaeda fruticosa* Hook. and Arn. Dondia intermedia.		3
B23083	22Z	do	Brown and gray rotten shale with iron concretion 25 feet below top of breaks.	1	....
B23084	22ZA	do	*Astragalus bisulcatus*		30
B23085	23	15 miles west of Bow Island on Route 3.	Brown loam, 0-12 inches	.3	...
B23086	23A	do	*Astragalus pectinatus*		570
B23087	24	36 miles west of Bow Island on Route 3.	Dark brown clay loam, 0-8 inches.	.7	....
B23088	24A	do	*Astragalus pectinatus*		1,680
B23089	25	1 mile west of Lethbridge	Gray clay, 0-18 inches	.3	.....
B23090	25A	do	*Astragalus bisulcatus*		470

TABLE 6.—*Selenium content of soils, shales, and vegetation from Canada*—Continued

ALBERTA—Continued

Laboratory No.	Field No.	Location	Material	Selenium as Se—	
				Soil or shale	Vegetation
				P. p. m.	*P. p. m.*
B23091	25W	1 mile west of Lethbridge	Gray shale. Pole beds member of Belly River formation.	0.8	
B23092	25X	do	Giant sandstone concretion 5 feet above 25W.	.4	
B23093	25Y	do	Yellow and brown sandy shale, 25 feet above 25W.	1.5	
B23094	25Z	do	Gray sandy shale, 30 feet above 25W.	1.5	
B23095	26X	6 miles northeast of Milk River.	Rotten gray sandy shale, Pakowki formation.	.3	
B23096	26Y	do	Gray and brown sandy shale, 10 feet above 26X.	.8	
B23097	26Z	do	Rotten gray shale, 40 feet above 26X.	.5	
B23098	26ZA	do	*Astragalus pectinatus*		670
B23099	27W	13 miles east of Milk River (Verdigris Coulee).	Greenish yellow sandstone, 4 feet thick, in upper Milk River formation.	1	
B23100	27X	do	Gray sandy shale, 9 feet above 27W.	.7	
B23101	27Y	do	Brown and purple concretion, 15 feet above 27W.	.7	
B23102	27Z	do	Gray sandy shale, 27 feet above 27W.	.5	
B23103	28	12 miles east of Milk River (Verdigris Coulee).	Yellow sandy loam, 0–12 inches	.3	
B23104	28A	do	*Astragalus pectinatus*		340
B23105	29W	12 miles east and 2¼ miles south of Milk River (Verdigris Coulee).	Gray clayey sandstone. Lower Milk River formation.	.7	
B23106	29X	do	Gray sandy clay, 75 feet above 29W.	.4	
B23107	29Y	do	Yellowish brown sandy concretions 125 feet above 29W.	.5	
B23108	29Z	do	Light gray sandstone, 125 feet above 29W.	.1	
B23117	30	¼ mile north of Coutts on Route 4.	Sandy loam, 0–8 inches	.4	
B23118	30A	do	*Astragalus pectinatus*		190
B23119	31	4 miles north of Coutts on Route 4.	Clay loam, 0–8 inches	.7	
B23120	31A	do	*Astragalus pectinatus*		280
B23121	32	10 miles north of Coutts on Route 4.	Sandy loam, 0–8 inches	.2	
B23122	32A	do	*Astragalus pectinatus*		140
B23123	33	32 miles north of Coutts on Route 4.	Fine sandy loam, 0–8 inches	.5	
B23124	33A	do	*Astragalus pectinatus*		150
B23125	34	45 miles northwest of Coutts on Route 4.	Fine sandy loam, 0–8 inches	.3	
B23126	34A	do	*Thlaspi arvense* L. (field pennycress).		12
B23127	34B	do	*Sisymbrium altissimum* L.		35
B23128	34C	do	*Astragalus pectinatus*		700
B23129	35	About 80 miles northwest of Coutts on Route 4.	Gray shale (Bearpaw formation).	.5	
B23130	35	do	Concretions in shale	.4	
B23131	35	do	Gray shale, 5 feet above B23129	1.5	
B23132	36	93 miles southeast of Calgary on Route 23.	Brown sandy loam, 0–8 inches	1	
B23133	36A	do	*Astragalus pectinatus*		1,200
B23134	37	82 miles southeast of Calgary on Route 23.	Brown sandy loam, 0–8 inches	1	
B23135	37A	do	*Astragalus pectinatus*		460
B23136	38	200 yards south of Mounted Police Station at Morley.	Hard gray shale, 35 feet from road.	1	
B23137	38	do	Iron oxide seam in shale, 40 feet from road.	1	
B23138	38	do	Yellowish clay seam in shale, 45 feet from road.	.5	
B23139	38	do	Chalk layer shale, 50 feet from road.	1	
B23140	39	1½ miles east of Morley	Gravelly gray sandy loam, 0–8 inches.	.5	
B23140A	39A	do	*Astragalus succulentus* Richards.		25
B23141	40	3 miles east of Morley	Black shale	.3	

TABLE 6.—*Selenium content of soils, shales, and vegetation from Canada*—Continued

ALBERTA—Continued

Laboratory No.	Field No.	Location	Material	Selenium as Se—	
				Soil or shale	Vegetation
				P. p. m.	*P. p. m.*
B23142	40	3 miles east of Morley	Yellowish red shale	0.3	
B23143	41	13 miles east of Morley	Brown clay loam, 0–8 inches	.5	
B23144	41	do	Low-grade coal	2	
B23145	42	5 miles west of Calgary on Route 1.	Dark brown loam, 0–8 inches	1.5	
B23146	42A	do	*Astragalus pectinatus*		730
B23147	43	20 miles east of Calgary on Route 9.	Clay, 3–4 feet	1	
B23148	43A	do	*Astragalus pectinatus*		1,130
B23149	44	20 miles west of Drumheller on Route 9.	Rotten shale, 3 feet	.3	
B23150	44A	do	*Astragalus bisulcatus*		60
B23151	45	3 miles north of Drumheller on Route 9.	Clay	.5	
B23152	45A	do	*Astragalus bisulcatus*		140
B23153	45X	3 miles north of Drumheller	Concretions and clayey shale	.4	
B23154	46	Lake Sullivan, 13 miles southeast of Halkirk.	Sandy loam, 0–8 inches	.1	
B23155	46A	do	*Astragalus bisulcatus*		12
B23156	46B	do	*Astragalus goniatus* (Torr. and Gray) Nutt.		25
B23157	46C	do	*Astragalus multiflorus* Gray		80
B23158	46D	do	*Astragalus* hay (mixed 46A, 46B, 46C) (3 years old).		20
B23159	47	13 miles southeast of Brooks on Route 2.	Gray silt loam, 2–3 feet	.4	
B23160	47A	do	*Astragalus pectinatus*		1,390
B23161	48	36 miles southeast of Brooks on Route 2.	Sandy loam, 0–12 inches	.3	
B23162	48A	do	*Astragalus pectinatus*		190
B23163	48B	do	*Cheirinia inconspicua* Rydb. (mustard).		10
B23164	48C	do	*Pentstemon albidus* Nutt		60
B23165	49	Medicine Hat on Route 2	Sandy loam	.4	
B23166	49A	do	*Astragalus bisulcatus*		100
B23167	49B	do	*Aplopappus nuttallii* Torr. and Gray.		100
B23168	50	5 miles east of Medicine Hat on Route 2.	Sandy loam, 0–8 inches	.5	
B23169	50A	do	*Astragalus pectinatus*		610
B23170	50B	do	*Cheirinia aspera* Rydb. (Prairie Rocket).		15

SASKATCHEWAN

B23022	5	10 miles south of Outlook on Route 45.	Gray brown high organic layer, 0–4 inches.	3	
B23023	5	do	Yellowish brown loam, 4–18 inches.	1.5	
B23024	5	do	Mottled yellowish brown loam, 18–30 inches.	.7	
B23025	5A	do	*Astragalus pectinatus*		1,000
B23026	6	10 miles west of Elbow	Dark gray clay, 0–10 inches	.5	
B23027	6A	do	*Astragalus bisulcatus*		15
B23028	6B	do	*Astragalus missouriensis* Nutt		5
B23029	6C	do	*Oxytropis gracilis* K. Schum		4
B23030	6D	do	*Chamaerhodos nuttallii* (Rydb.) Pickering.		20
B23031	6E	do	*Astragalus* sp		10
B23032	7W	4 miles east of Elbow	Gray fissile shale (Bearpaw formation).	3.5	
B23033	7X	do	Iron concretions in 7W	.5	
B23034	7Y	do	Greenish yellow material, 5 feet above 7W.	1	
B23035	7Z	do	Gray shale, 18 feet above 7W	3	
B23036	8	4 miles east of Elbow (200 yards from 7W).	Brown clay loam, 0–10 inches	1.5	
B23037	8A	do	Yellow compositae		15
B23038	8B	do	*Astragalus pectinatus*		4,000
B23039	8C	do	*Aplopappus spinulosus* (Pursh) DC.		200

TABLE 6.—*Selenium content of soils, shales, and vegetation from Canada*—Continued

SASKATCHEWAN—Continued

Laboratory No.	Field No.	Location	Material	Selenium as Se—	
				Soil or shale	Vegetation
				P. p. m.	*P. p. m.*
B23040	0	2 miles south of Herbert on Route 1.	Gray clay loam, 0–8 inches	1	
B23041	9A	do	*Astragalus pectinatus*		1,150
B23042	10X	33 miles south of Swift Current on Route 4.	Shale (Bearpaw formation)	1	
B23043	11	6 miles west of Cadillac	Clay loam, 0–12 inches	.7	
B23044	11A	do	*Astragalus bisulcatus*		1,020
B23045	11B	do	*Hymenoxys richardsoni* Cock. (Colorado rubber plant).		20
B23046	11X	6 miles west of Cadillac, 30 feet east of 11.	Gray shale (Bearpaw formation).	.5	
B23047	11Y	do	Brown nodules in 11X	1.5	
B23048	12	4 miles northeast of East End at exposure of East End formation.	Gray clay, 0–12 inches	2	
B23049	12A	do	*Astragalus pectinatus*		1,210
B23050	12U	4 miles northeast of East End	Gray shale, 0–12 inches (East End formation).	.4	
B23051	12V	do	Massive limestone, 12–15 inches thick, below 12U.	.2	
B23052	12W	do	Yellow shale, 3–4 feet above 12V	.5	
B23053	12X	do	Laminated yellow and gray sandy shale, 10 feet below 12V.	.5	
B23054	12Y	do	Yellow clay shale, 25 feet below 12V.	.5	
B23055	12Z	do	Gray clay shale, 25–26 feet below 12V.	.4	
B23056	13X	1½ miles west of East End	White clay (Whitemud formation).	.5	
B23057	13Y	do	Red clay, 15 feet above 13X	.7	
B23058	14	9 miles southwest of East End on Route 13.	Brown clay loam, 0–8 inches	.3	
B23059	14A	do	*Astragalus pectinatus*		160
B23060	15	10 miles south of Maple Creek on Route 21.	Gray clay loam, 0–6 inches	1	
B23061	15	do	Zone of lime accumulation, 6–15 inches.	1	
B23062	15	do	Transition from lime zone to gray clay, 15–24 inches.	.5	
B23063	15	do	Gray clay, 24–36 inches	.3	
B23064	15A	do	*Astragalus bisulcatus*		50
B23065	15B	do	*Poa canbyi* (Scribn.) Piper (Canby bluegrass).		8
B23066	16	12 miles northwest of Maple Creek on Route 1.	Brown sandy loam, 0–8 inches	.5	
B23067	16A	do	*Astragalus pectinatus*		160
B23171	51	13 miles east of Maple Creek on Route 1.	Sandy loam, 0–10 inches	.3	
B23172	51A	do	*Astragalus pectinatus*		2,310
B23173	52	60 miles east of Maple Creek on Route 1.	Sandy loam, 0–10 inches	1	
B23174	52A	do	*Astragalus pectinatus*		700
B23014	1	3 miles north of Swift Current on Route 4.	Gray rotten shale, 10 feet	1.5	
B23015	1A	do	*Astragalus pectinatus*		3,360
B23016	2	24 miles north of Swift Current.	Gray brown loam, 0–10 inches	.8	
B23017	2A	do	*Astragalus bisulcatus*		1,150
B23175	53	30 miles north of Swift Current on Route 4.	Clay loam, 0–10 inches	.7	
B23176	53A	do	*Astragalus bisulcatus*		490
B23177	54	35 miles north of Swift Current on Route 4.	Rotten shale (Bearpaw formation).	.1	
B23178	54A	do	*Astragalus bisulcatus*		340
B23179	50	66 miles north of Swift Current on Route 4.	Clay loam, 3 feet	.5	
B23180	56A	do	*Astragalus pectinatus*		120
B23180B	56B	do	Bugs taken from 56A		17
B23180A	56C	do	Large mushroom		10
B23018	3	103 miles north of Swift Current on Route 4.	Gray clay, 2–2½ feet	1.5	
B23019	3A	do	*Astragalus bisulcatus*		3,640
B23020	4	109 miles north of Swift Current on Route 4.	Gray fissile shale, 20–21 feet	1	

TABLE 6.—*Selenium content of soils, shales, and vegetation from Canada*—Continued

SASKATCHEWAN—Continued

Laboratory No.	Field No.	Location	Material	Selenium as Se—	
				Soil or shale	Vegetation
				P. p. m.	*P. p. m.*
B23021	4A	100 miles north of Swift Current on Route 4.	*Astragalus pectinatus*		2,440
B23181	57A	7 miles north of Rosetown on Route 4.	Young *Astragalus bisulcatus* (on glacial drift).		3,240
B23182	58	3 miles east of Biggar on Route 14.	Brown loam, 3 feet	0.4	
B23183	58A	do	*Astragalus pectinatus*		220
B23184	59	University campus, Saskatoon.	Dark-brown loam, 0–8 inches	6	
B23185	59A	do	*Astragalus pectinatus*		1,540
B23186	60	13 miles east of Saskatoon on Route 14.	Brown loam, 0–8 inches	1	
B23187	60A	do	*Astragalus pectinatus*		780
B23188	60B	do	Young spring wheat		30
B23189	61	64 miles east of Saskatoon on Route 14.	Brown loam, 0–10 inches	1.5	
B23190	61	do	Yellow loam, 18–20 inches Calcareous.	.5	
B23191	61A	do	*Astragalus pectinatus*		1,100
B23192	62	104 miles east of Saskatoon on Route 14.	Dark-brown loam, 0–12 inches	.3	
B23193	62A	do	*Astragalus bisulcatus*		500
B23194	63	3 miles southeast of Kamsack on Route 8.	Gray clay, 1–2 feet	.4	
B23195	63A	do	*Astragalus bisulcatus*		640
B23196	64	do	Rotten clay shale, 10 feet below surface. Riding with beds.	.4	
B23197	64A	do	Dandelions		110
B23198	65	2½ miles southeast of Kamsack on Route 8.	Ironstone concretion in shale	.4	
B23199	65	do	Raw gray shale, 3–4 feet	.5	
B23200	65A	do	*Hedysarum* sp.(?)		60
B23201	66	do	Clay loam, 0–8 inches	4	
B23202	66A	do	*Astragalus bisulcatus*		350
B23203	66X	do	Gray shale from cut	.3	
B23204	66Y	do	Yellowish brown coating on large gray concretion.	1.5	
B23205	66Z	do	Black core of large gray concretion.	1.5	
B23206	67	Below powerhouse at Kamsack.	Rotten gray shale with yellow streaks.	1.5	
B23207	68	56 miles southeast of Yorkton on Route 14.	Gravelly clay loam, 1–1½ feet	.2	
B23208	68A	do	*Astragalus bisulcatus*		320
B23220	75	18 miles north of Burrows on road to Esterhazy.	Rotten clay shale	1.5	
B23221	76	18.3 miles north of Burrows on road to Esterhazy.	Unweathered shale	.5	
B23222	77	18.7 miles north of Burrows on road to Esterhazy.	Heavy gray clay, 5–6 feet	.5	
B23223	77A	do	*Astragalus bisulcatus*		420
B23224	78	20.3 miles north of Burrows on road to Esterhazy.	Hard, nearly white shale	.3	
B23225	79	1 mile west of Broadview on Route 1.	Black loam, 0–8 inches	1.5	
B23226	79A	do	*Astragalus pectinatus*		4,190
B23227	79B	do	Western wheatgrass		35
B23228	79C	1 mile west of Broadview on Route 1, 50 feet from 79.	*Astragalus bisulcatus*		1,020
B23274	80	23 miles west of Grenfell on Route 1.	Brown loam, 0–8 inches	1	
B23275	80	do	Yellowish brown clay loam, 4½–5 feet.	.5	
B23276	80A	do	*Astragalus pectinatus*		1,040
B23277	81	61 miles west of Grenfell on Route 1.	Brown loam, 0–8 inches	4	
B23278	81A	do	*Astragalus pectinatus*		2,590
B23279	82	13 miles south of Regina on Route 6.	Gray clay loam, 0–8 inches	1	
B23280	82A	do	Young wheat, 4 inches		120
B23281	83	36 miles southeast of Regina on Route 39.	Yellow brown clay loam, 0–8 inches.	.7	
B23282	83A	do	*Astragalus bisulcatus*		1,950
B23283	83B	do	Young wheat		140
B23284	84	57 miles southeast of Regina on Route 39.	Brown loam, 0–8 inches	6	

TABLE 6.—*Selenium content of soils, shales, and vegetation from Canada*—Continued

SASKATCHEWAN—Continued

Laboratory No.	Field No.	Location	Material	Selenium as Se—	
				Soil or shale	Vegetation
				P. p. m.	*P. p. m.*
B23285	84A	57 miles southeast of Regina on Route 30.	*Astragalus pectinatus*		2,370
B23286	85	1 mile southeast of Weyburn on bank of Souris River on Route 39.	Dark gray clay loam, 0-8 inches	0.7	
B23287	85A	do	*Astragalus bisulcatus*		2,130
B23288	86	22 miles southeast of Weyburn on Route 39.	Light brown loam, 0-8 inches	.4	
B23289	86A	do	*Astragalus pectinatus*		650
B23290	87	31 miles southeast of Weyburn on Route 39.	Gray-brown clay loam, 0-8 inches.	1	
B23291	87A	do	*Astragalus bisulcatus*		830
B23292	87B	do	Lambsquarters (*Chenopodium* sp.).		45
B23293	88	At mine in Estevan	Yellow seam, 2 feet above cool seam.	.5	
B23294	89	13 miles southeast of Estevan on Route 39.	Rotten clay shale and clay, 3 feet below surface.	1	
B23295	89	do	Gray clay shale, 10 feet below surface.	.7	
B23296	89A	do	*Astragalus pectinatus* (seeds)		2,530
B23297	90	24 miles southeast of Estevan on Route 39.	Gray clay loam, 4–4½ feet	.4	
B23298	90A	do	*Astragalus pectinatus*		1,650

MANITOBA

B23209	69	½ mile east of Saskatchewan-Manitoba line on Route 4.	Dark gray clay loam, 0-12 inches	0.3	
B23210	69A	do	*Astragalus bisulcatus*		330
B23211	70	1½ miles east of Saskatchewan-Manitoba line on Route 4.	Rotten clay shale, 20 feet below surface.	1.5	
B23212	71	2 miles east of Saskatchewan-Manitoba line on Route 4.	Rotten gray shale	.3	
B23213	71A	do	*Astragalus bisulcatus*		420
B23214	72	17 miles southeast of Russell on Route 4.	Gray brown clay, 0-12 inches	.4	
B23215	72A	do	*Astragalus bisulcatus*		880
B23216	73	5 miles southwest of Minnota, base of bluffs of Assiniboine.	Gray clay loam, 0-12 inches	.7	
B23217	73A	do	*Astragalus bisulcatus*		160
B23218	74	4 miles west of Elkhorn on Route 1.	Black clay loam, 2-3 feet	.7	
B23219	74A	do	*Astragalus bisulcatus*		800

The data given in table 6 show that the geological samples ranged in selenium content from 0.1 to 3.5 p. p. m., the soils from 0.1 to 6 p. p. m., and the vegetation from 3 to 4,190 p. p. m. About 63 percent of the soils contained less than 1 p. p. m. All of the samples of *Astragalus bisulcatus* and *A. pectinatus* contained sufficient selenium to be toxic, and ranged from 15 to 4,190 p. p. m. The *Astragalus* samples show the same variation in selenium content that has been observed elsewhere; this may be considered as indicating a wide variation in the intensity of toxicity of the soils.

Definitely toxic vegetation is produced on soils derived from Cretaceous shales over very considerable areas in Alberta, larger areas in Saskatchewan, and a much smaller area in Manitoba. No estimate is offered concerning the number of square miles involved. Such an estimate is impossible, not only because of the limited scope of the investigation but also because no attempt was made to sample

areas not shown as Cretaceous and because areas of Cretaceous origin were sampled only if external indications of the presence of selenium were observed. The reconnaissance survey does, however, bring out the desirability of more detailed work in the Provinces on the distribution of selenium in the soils and the degree of toxicity of the vegetation.

One of the most interesting observations made was that in the section about Lake Sullivan, Alberta. Hay, consisting in part of *Astragalus bisulcatus*, was used for feed during periods of feed shortage due to drought. One of these cases was investigated. The farmer who was questioned reported that very little of this hay was actually eaten, and that it was offered to the animals but once a week. His observation was that horses refused it absolutely and cattle and sheep ate it very sparingly. He considered this to be due to the presence of unpalatable foxtail, which formed a part of the hay. Because the

FIGURE 3.—A cow showing the characteristic symptoms of chronic selenium poisoning—poor coat, nude tail, and striated, elongated hoofs.

animals refused the hay, it was disposed of by use as thatch for the stables. The 3-year-old hay (B23158) was found to contain 20 p. p. m. of selenium. *A. bisulcatus* (B23155), *A. goniatus* (Torr. and Gray) Nutt. (B23156), and *A. multiflorus* (B23157), collected from the hay field, contained 12, 25, and 80 p. p. m., respectively. It is clear that this material is unfit for forage and was so recognized by the animals themselves.

Oral information points to considerable injury to and loss of stock through troubles known locally as "frozen feet." One of the characteristics of chronic selenium poisoning is malformation and even loss of hoofs of livestock. These effects can well be mistaken as due to freezing. How extensive this loss is and how fully due to chronic selenium poisoning may be ascertained only by a detailed study of the areas.

South of Herbert, Saskatchewan, horses were observed with coats that were very thin in places and with hairless tails. Cattle nearby had striated and elongated hoofs. Their tails were nude. This

condition can be noted in figure 3. A sample of soil (B23040) collected nearby contained 1 p. p. m. and the *Astragalus pectinatus* (B23041) growing on it contained 1,150 p. p. m. of selenium. It is probable that the animals were affected with chronic selenium poisoning.

Pasture land for miles east of Maple Creek along Route 1 is dotted with *Astragalus pectinatus*. Sample B23172 contained 2,310 p. p. m. of selenium and sample B23174 contained 790 p. p. m. Figure 4 shows the *A. pectinatus* in bloom where sample B23172 was collected.

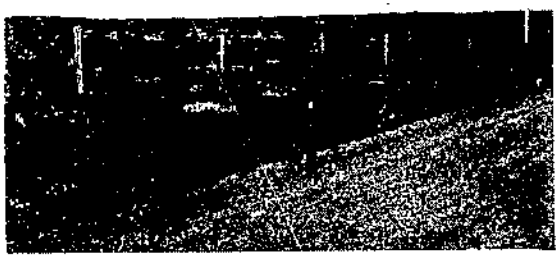

FIGURE 4.—*Astragalus pectinatus* in bloom.

For over 160 miles to the east of Saskatoon, Saskatchewan, *Astragalus* plants were noted at intervals along Route 14. At a point 64 miles east of Saskatoon a group of *Astragalus pectinatus* plants was found growing within 50 feet of trees, primarily aspen trees (fig. 5). Only once before, in a portion of San Isabel Forest, have the authors found vegetation toxic from selenium in an area of sufficient rainfall to support trees (*9*). In San Isabel Forest the trees were sparse and the mean annual rainfall was 21 inches. In this area, east of Saskatoon, the rainfall must be somewhat greater. The sample of *A. pectinatus* collected here (B23191) contained 1,100 p. p. m. of selenium.

Southeast of Weyburn, Saskatchewan, along Route 39, *Astragalus bisulcatus* was found to flourish. A sample of soil (B23290), collected 31 miles southeast of Weyburn, contained 1 p. p. m., the *A. bisulcatus* plant growing in it (fig. 6) 830 p. p. m., and a sample of lambsquarters growing nearby 45 p. p. m. of selenium.

FIGURE 5.—*Astragalus pectinatus* growing in a region of rainfall sufficient to support trees.

The selenium content of young wheat samples, B23078 from Alberta and B23188, B23280, and B23283 from Saskatchewan, was 80, 30, 120, and 140 p. p. m., respectively, and indicates the distinct possibility of toxic vegetation of the ordinary food or forage types. The quantities of selenium found in samples B23070, B23075, B23127, B23163, and B23164 from Alberta and B23065, B23197, B23227, and B23292 from Saskatchewan also point

clearly to the presence of toxic areas of farm and ranch land and the probabilities of toxic food in certain areas.

Although the existence of an enormous area of seleniferous soil is revealed and although definite evidence of injury is apparent, it does not follow that the situation is sufficiently serious to warrant any drastic remedial procedures except as further investigation of local areas may indicate. It does seem imperative, however, that a detailed study be made so that proper precautions may be taken as necessary. The evidence, taken together with previously assembled data, indicates very decidedly that overgrazing of the affected lands may produce serious injury through consumption by hungry animals of toxic plants not normally eaten by animals.

FIGURE 6.—A thrifty *Astragalus bisulcatus* plant.

SELENIUM IN NORTH DAKOTA

In the early part of the summer of 1938 two of the authors made a reconnaissance examination of Burke, Mountrail, Ward, and Williams Counties in North Dakota. The results are tabulated in table 7.

TABLE 7.—*Selenium content of soils, shales, and vegetation from North Dakota*

BURKE COUNTY, N. DAK.

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B23299	R1	200 yards from immigration office, North Portal, Canada line.	Brown clay loam, 0-8 inches.	0.7	
B23300	R1A	do	*Astragalus bisulcatus*	280	
B23301	R2	9½ miles south of North Portal.	Brown loam, 0-8 inches	2	
B23302	R2	do	Lime zone	1	
B23303	R2A	do	*Astragalus pectinatus*	580	
B23304	R3	4 miles southeast of Flaxton.	Brown clay loam, 0-8 inches.	1.5	
B23305	R3A	do	*Astragalus pectinatus*	1,440	

MOUNTRAIL COUNTY, N. DAK

B23316	R8	14 miles west of junction of Routes 23 and 22 on Route 23.	Heavy dark clay, 5 feet	0.5	
B23317	R8A	do	*Astragalus bisulcatus*	60	
B23318	R8N	do	Yellow concretions	2	15 feet below B23316.
B23319	R9	Van Hook, on Route 23	Gray brown loam, 0-8 inches.	1	
B23320	R9A	do	*Astragalus pectinatus*	540	
B23321	R9B	do	*Astragalus* sp.	7	
B23322	R10	12 miles east of Van Hook	Brown clay loam, 0-8 inches.	.7	
B23323	R10A	do	*Astragalus bisulcatus*	470	
B23324	R10B	do	Young wheat	5	
B23326	R12	31 miles west of Minot on Route 2.	Gray brown loam, 10-18 inches.	.7	
B23329	R12A	do	*Astragalus pectinatus*	1,300	

TABLE 7.—*Selenium content of soils, shales, and vegetation from North Dakota*—Continued

WARD COUNTY, N. DAK.

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B23306	R4	31 miles southeast of Flaxton.	Gray clay loam, 0–18 inches.	0.5	
B23307	R4A	do	*Astragalus bisulcatus*	180	
B23308	R4B	do	*Astragalus pectinatus*	1,660	
B23309	R5	5 miles west of Route 83 on Route 53.	Rotten clay shale	.5	
B23310	R5X	do	Hard clay shale	.1	
B23311	R5A	do	*Astragalus bisulcatus*	130	
B23312	R6	11 miles west of Route 83 on Route 53.	Gravelly clay, 4 feet	1	
B23313	R6A	do	*Astragalus bisulcatus*	430	
B23314	R6B	do	*Astragalus pectinatus*	480	
B23325	R11	31 miles east of Van Hook on Route 23.	Gravelly clay, 3 feet	2	
B23326	R11A	do	*Astragalus pectinatus*	1,340	
B23327	R11B	do	*Chrysopsis villosa* Nutt.	7	
WILLIAMS COUNTY, N. DAK.					
B23330	R13	78 miles west of Minot on Route 2.	Gray brown loam, 18–24 inches.	0.7	
B23331	R13A	do	*Astragalus pectinatus*	280	
B23332	R14	2 miles west of Muddy Creek.	Gravelly clay, 36–42 inches.	.5	130 miles west of Minot.
B23333	R14A	do	*Astragalus pectinatus*	890	

A considerable portion of the area examined is covered by soil derived from glacial drift. The Fort Union formation of Eocene series underlies the glacial material. *Astragalus pectinatus* and *A. bisulcatus* were used as guides in making the collections. Although these plants occur commonly in much of the area, only a few samples were collected.

Thirty-four samples of soil, shale, and vegetation were collected at 13 stations. The selenium content of the 12 samples of soil ranged from 0.5 p. p. m. to 2 p. p. m. The 9 samples of *Astragalus pectinatus* varied in selenium content from 280 p. p. m. to 1,660 p. p. m. Six samples of *A. bisulcatus* contained from 60 p. p. m. to 470 p. p. m. of selenium. A sample of young wheat (B23324), growing within 20 feet of an *A. bisulcatus* plant, contained 5 p. p. m. The *A. bisulcatus* plant (B23323) contained 470 p. p. m., and the soil under the *Astragalus* (B23322) contained 0.7 p. p. m. of selenium.

These data, together with the analysis of wheat from North Dakota tabulated in table 1, indicate a continuation of the seleniferous area in Montana eastward into North Dakota to a distance of at least 100 miles east of the border. Samples taken along transects of this glaciated area probably would give interesting data on the source and movement by glaciation of the parent seleniferous material. Certainly further investigation of the area seems warranted.

MONTANA SOIL PROFILES

The data obtained in the survey of Montana in 1937 (*55*) showed that in some cases the selenium content of the surface 8 inches of soil was low, that is, 0.5 p. p. m. or less, and yet the selenium content of the *Astragalus* plants growing on it was high, that is, over 1,000 p. p. m.

In other cases the soils were relatively much higher in selenium content and the *Astragalus* plants much lower. The following year (1938) four locations were selected in Teton County and soil profiles and plants were collected for selenium analysis. Two of these locations were selected in which the soil was low in selenium content and the plants high, and two were selected in which the soil was high and the plants relatively low. A fifth profile was collected at a new location. The data are given in table 8.

Profiles (field Nos.) 2 and 3 are of low selenium content through their entire depth, yet the selenium content of the *Astragalus* growing on them was high both years (see table 8 and (*55*)). In profile 3, if the plant were feeding from the soil containing 0.2 p. p. m. of selenium, the plant increases the concentration 10,000 times. Every ounce of air-dried material produced by the plant, with a selenium content of 2,140 p. p. m., would require all the selenium from 668 pounds of the soil containing 0.2 p. p. m.

The selenium content of profile 4 is relatively much higher and yet the selenium content of *Astragalus* collected in 1937 (*55*) was 80 p. p. m. and in 1938 it was 170 p. p. m.

At the location of profile 1 (1938), the *Astragalus* plant sampled in 1938 is the same one that was sampled in 1937 (the plant grows anew each spring from the same root). The surface soil was taken directly under the plant each time and the variation in the selenium content of the surface 6 inches may be due to the fluctuation in organic selenium from the decay of plant material. The selenium in the remainder of the profile averaged 1 p. p. m. When sampled in 1937 (*55*) the plant contained 700 p. p. m., and in 1938 it contained 1,340 p. p. m.

Profile 5 was collected at a new location. It was found to be of low selenium content to a depth of 44 inches and the *Astragalus* growing in it contained but 10 p. p. m.

TABLE 8.—*Selenium content of soil profiles and vegetation in Teton County, Mont.*

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B21553	20	20 feet northwest of S.E. corner sec. 1, T. 26 N., R. 2 W.	Scobey loam	0.5	1937.
B21554	20A	do	*Astragalus pectinatus*	1,560	Do.
B23241	2	do	Scobey loam, 0–6 inches	1	
					1938
B23242	2	do	Scobey loam, 6–12 inches	.3	At same point as No. 20, 1937 collection.
B23243	2	do	Scobey loam, 12–20 inches	.2	
B23244	2	do	Scobey loam, 20–30 inches	.2	
B23245	2	do	Scobey loam, 30–40 inches	.3	
B23245A	2X	do	Gravel:		
			Sandstone, 20–25 inches	.5	
			Clay shale	.1	
B23246	2A	do	*Astragalus pectinatus*	1,330	
B23247	2B	do	Young Russian-thistle	18	Within 10 feet of soil.
B23248	2C	do	Young wheat	5	Within 40 feet of soil.
B23249	2D	do	Scarlet mallow	5	Within 15 feet of soil.
B23250	2F	do	Tumble mustard	20	Within 20 feet of soil.
B21718	78	300 yards northwest of E¼ corner sec. 25, T. 23 N., R. 4 W.	Morton sandy loam	.4	1937.
B21719	78A	do	*Astragalus pectinatus*	1,070	Do.

TABLE 8.—*Selenium content of soil profiles and vegetation in Teton County, Mont.*—Continued

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
					1938
				P. p. m.	
B23251	3	300 yards northwest of E¼ corner sec. 25, T. 23 N., R. 4 W.	Morton sandy loam, 0–6 inches.	0.5	Within 50 feet of same location as No. 78, 1937 collection.
B23252	3	do	Morton sandy loam, 6–14 inches.	.3	
B23253	3	do	Morton sandy loam, 14–20 inches.	.2	
B23254	3	do	Morton sandy loam, 20–30 inches.	.2	
B23255	3	do	Morton sandy loam, 30–50 inches.	.2	
B23256	3A	do	*Astragalus pectinatus*	2,140	
B23257	3B	do	Scarlet mallow	35	Within 5 feet of soil.
B23258	3C	do	Spear grass	7	Within 10 feet of soil.
B21513	1	NE¼ of SE¼ sec. 19, T. 24 N., R. 24 W.	Burton clay loam	2.5	1937.
B21514	1A	do	*Astragalus bisulcatus*	80	Do.
B23259	4	do	Burton clay loam, 0–8 inches.	1	
B23260	4	do	Yellow band in shaly soil, 20–24 inches.	1.5	
B23261	4	do	Rotten gray shale, 2–4 feet	1.5	
B23262	4	do	Gray shale banded with yellow, 7–8 feet.	1.5	
B23263	4	do	Hard yellow layer, one-half inch at 12 feet.	5	
B23264	4	do	Hard raw gray shale, 12–13 feet.	4	
B23264A	4	do	Yellow bentonite seam, 1½ inches thick, 30 feet depth.	3 2.5	
B23265	4	do	Raw gray shale, 30–31 feet	3	
B23266	4A	do	*Astragalus bisulcatus*	170	At 7–8 feet.
B21570	28	25 yards northwest of SE. corner sec. 24, T. 25 N., R. 2 W.	Scobey silt loam, 0–8 inches.	3.5	1937.
B21571	28A	do	*Astragalus pectinatus*	700	Do.
					1938
B23232	1	do	Scobey silt loam, 0–6 inches.	6	Same location as No. 28, 1937 collection.
B23233	1	do	Scobey silt loam, 6–15 inches.	1	
B23234	1	do	Scobey silt loam, 15–24 inches.	1	
B23235	1	do	Scobey silt loam, 24–36 inches.	1.5	
B23236	1	do	Gray shaly clay, 14–15 feet	.5	
B21237	1X	do	A concretion at 30 inches	12	
B23238	1Y	do	Brown fragments in profile.	2	
B23239	1A	do	*Astragalus pectinatus*	1,340	Same plant sampled in 1937.
B23240	1B	do	Grass	12	Sample for identification.
B23267	5	0.1 mile west of SW. corner sec. 10, T. 24 N., R. 3 W.	Scobey silt loam, 0–5 inches.	.5	
B23268	5	do	Scobey silt loam, 5–14 inches.	.2	
B23269	5	do	Scobey silt loam, 14–36 inches.	.3	
B23270	5	do	Scobey silt loam, 36–44 inches.	.4	
B23271	5	do	Scobey silt loam, 44–54 inches.	2	
B23272	5A	do	*Astragalus pectinatus*	10	Within 25 feet of soil.
B23273	5B	do	Young wheat	.5	Within 15 feet of soil.

SPECIAL ITEMS

Selenium in Normal Urine

As stated previously (p. 31), the authors believe selenium to be a normal constituent of soils and to be absorbed at least in minute amounts by all vegetation. As some of the elimination of selenium in the animal body is through the urine, normal urine should contain detectable amounts of selenium. Several samples were collected, and the results are reported in table 9.

Samples 1 and 5 were furnished by members of the Division of Soil Chemistry and Physics while they were engaged in field work in seleniferous areas. Samples 2, 3, 4, and 6 were furnished by the same individuals after their return to Washington, D. C.

Samples 7 to 12 were secured from members of this Division who were not engaged in selenium work. Samples 7 to 10 were furnished by one individual at various intervals and show an interesting variation in content.

Samples 13 to 19 were collected from people in different walks of life, all living in Washington, D. C., or its environs.

The results of analyses of urine from horses on normal rations at the Beltsville Research Center, Beltsville, Md., made by one of the authors in connection with other work, are also given.

All of the samples examined contained selenium. The reagents were free of detectable amounts of the element. Selenium then appears to occur normally in urine in areas that are not seleniferous.

Table 9.—*Selenium content of urine*

Laboratory No.	Specimen No.	Source	Selenium as Se
			Parts per billion
B23343	1	Chemist in seleniferous area	40
B23344	2	Chemist 8 days after return to Washington	20
B23344A	3	Chemist 15 days after return to Washington	20
B23344B	4	Chemist 22 days after return to Washington	3
B24783	5	Chemist on leaving seleniferous area	40
B25359	6	Chemist 6 months after return to Washington	10
B23344C	7	Soil chemist	7
B23344D	8	do	70
B25254	9	do	15
B25255	10	do	25
B24782	11	Organic chemist	10
B24840	12	Analytical chemist	20
B25875	13	Vitamin chemist	25
B25876	14	Housewife	25
B25877	15	Retired naval officer	2
B25878	16	Schoolboy	20
B25879	17	do	25
B25880	18	Housewife	2
B25881	19	Schoolboy	2
B21651	20	Horse	50
B21654	21	do	50
B21657	22	do	50

Selenium in Meteorites

The recent work on seleniferous soils and plants has developed into an extensive and intensive examination of its distribution, quantitative relations, toxic effects on animals, etc. In the course of these investigations it has been found that selenium in readily ascertainable quantities is present in many thousands of square miles of soils, in soils or

plants from all the continents, and many groups of islands. It has been found in different quantities in all geological formations in which it has been sought, including recent deposits in deep-sea bottoms. Indeed, selenium has been found in almost all natural bodies where adequate search has been made. It seems probable, then, that selenium is a part of the normal intake of both plants and animals and that only in exceptional instances, numerous as they are, is its presence to be regarded as abnormal.

In view therefore of the interest attached to selenium, particularly to its distribution, it seemed worth while to determine if an astronomical relation could be established. No data are available of extraterrestrial character through the spectroscope. It appeared likely that information could be gained from an examination of meteorites that have reached the earth from outer space, although selenium is not listed by Merrill (*28*) as having been found in them. A collection of meteorites was therefore obtained through the kindness of E. P. Henderson, of the Smithsonian Institution. The results of an examination of them have been published in part (*7*). They are here recapitulated with additional data, and the results obtained from the examination of these samples are presented in table 10. The method employed for the isolation (*43*) and estimation (*51*) have been described previously.

TABLE 10. *Selenium content of meteorites*

Laboratory No.	Kind of meteorite	Location	Selenium
			P. p. m.
B22785	Hexahedrite	Negrillos, Chile	0.0
B22786	Chondrite	Allegan, Mich.	13
B22787	Mesosiderite	Estherville, Iowa	3
B22788	Chondrite	Tabory, Russia	10
B22789	Troilite	Canyon Diablo, Ariz.	235
B22790	Octahedrite, with schreibersite	do	.0
B22791	Octahedrite	Santa Rosa, Colombia	.0
B22792	do	Casas Grandes, Mexico	.0
B22924	Pallasite	Brenham, Kans.	2
B22925	Mesosiderite	Morristown, Tenn.	1
B22926	Fine octahedrite	Putnam County, Ga.	1
B22927	Octahedrite	Nashville, N. C.	3
B22928	do	40 miles south of Grants, N. Mex.	.5
B22929	do	Tazewell, Tenn.	.0
B22930	Chondrite	Tulia, Tex.	10
B22931	Coarsest octahedrite	New Baltimore, Pa.	.0
B22932	Stone	Salina Township, Kans.	3
B22933	Chondrite	15 miles south of Oakley, Kans.	2

It will be noted that, of the 18 samples examined, 12 contain selenium in amounts comparable with those found in analogous material from the earth's crust. In the cases reported as zero no detectable trace was found in a 10-gm. sample. Undoubtedly, if the integration procedure (*43*) were used, traces of selenium would be found in some or all of these.

A number of interesting facts are brought out by the data in table 10, in addition to the demonstration of the existence of selenium in extraterrestrial matter. One of these is that all the samples of stony meteorites—stone, chondrite, pallasite, and mesosiderite—have appreciable quantities of selenium, whereas the iron alloy samples of octahedrite contain none. Yet the concretion of iron sulfide, troilite, found in octahedrite meteors contains relatively enormous quantities of selenium (B22789). As selenium has always been

found in all the sulfide minerals so far examined (*53*), it seemed worth while to examine a second sample of troilite in order to determine the sulfur-selenium ratio. This was found to be: Sulfur, 37.32 percent or 373,200 p. p. m., and selenium, 200 p. p. m., or an atomic ratio of S/Se=4,215. This relative absence of selenium from octahedrite and its abundance in the sulfide nodules raised rather intriguing surmises concerning the origin of the latter.

After the publication (*7*) of the data discussed above, the analysis of meteorites for selenium by Warren (*48*) came to the authors' attention. Because the method used by Warren did not provide for adequate purification of the selenium and because the results he secured were deemed high by the authors, samples of the same meteorites that were used by Warren were secured through the kindness of William F. Foshag, of the Smithsonian Institution. The results of the analyses of these samples for selenium, together with Warren's values for selenium, are given in table 11.

TABLE 11.—*Comparison of analyses for selenium of certain samples of meteoric iron*

Laboratory No.	Source of meteoric iron	Selenium as Se	Selenium as Se [1]	Arsenic as As
		P. p. m.	*P. p. m.*	*P. p. m.*
B25937	Meteoric iron, Bohumilitz, Bohemia	2,300 and 500	1.4	1
B25938	Meteoric iron, Ellbogen, Bohemia	600	.0	7
B25939	Meteoric iron and Pallas iron, Krasnoyarsk, Siberia.	400	.4	1
B25940	Meteoric iron, Imilac (Atacama Desert, Chile)	800 and 500	2.0	8

[1] Analysis by H. N. Warren (*48*).
[2] Analysis by authors.

Arsenic was determined and found to be so low that it could not be considered the contaminant. If all of the sulfur used in the analyses by Warren was not oxidized, an amount of sulfur sufficient to account for the difference in results might have been distilled over. If oxygen was passed through the combustion tube at such a rate as to carry over dust, high values for selenium would result in Warren's method.

MISCELLANEOUS DATA

During the period of the systematic examinations reported herein, a number of samples from various sources were examined for reasons not directly concerned with the main purposes of the investigation. A portion of the data, so obtained, is of special, though sometimes of local, interest. These data are presented in table 12.

Fifteen samples of soils and vegetation (table 12) taken in the Snake River Valley in southwestern Idaho, were furnished by L. T. Giltner, of the Pathological Division, Bureau of Animal Industry. Six samples of *Stanleya* contained 0.5 p. p. m. (B25284) to 330 p. p. m. (B25261) of selenium. Four of these plants contained 10 p. p. m. or more of selenium. Two samples of soil, B25263 and B25276, contained 2.5 p. p. m. and 12 p. p. m., respectively. These data, together with those of Beath et al. (*3*) and Byers (*9*), indicate that the entire Great Basin area from Arizona to the Canadian border should be more closely investigated in order to determine whether the great alluvial and lacustrine deposits have local areas of toxic character.

TABLE 12.—*Selenium content of miscellaneous samples*

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B25261	38-134	Near Bliss, Idaho	*Stanleya* sp	330	Collected July 16, 1938.
B25274	38-135	Near Glenns Ferry, Idaho.	do	30	Do.
B25262	38-136	3 miles west of Hammett, Idaho.	do	16	Do.
B25275	38-136A	Near Hammett, Idaho	Soil near surface	2	Do.
B25276	38-136C	do	Soil, 30 feet below surface.	1.2	Do.
B25263	38-136B	3 miles north of Hammett, Idaho.	Soil, 4 feet below surface.	2.5	Do.
B25203	38-146	Mountain Home, Idaho.	*Stanleya* sp	3	Collected July 21, 1938.
B25204	38-146A	do	Soil from surface	.2	Do.
B25281	38-147	Near Bruneau, Idaho	*Stanleya* sp	160	Do.
B25282	38-147A	do	Soil from surface	.4	Do.
B25283	37-147B	do	*Atriplex canescens* S. Wats.	.5	Do.
B25265	38-147C	9 miles south of Bruneau, Idaho.	*Grayia spinosa*	.5	Collected July 12, 1938.
B25284	38-148	Near Grand View, Idaho.	*Stanleya* sp	.5	Collected July 21, 1938.
B25285	38-148A	do	Soil from surface	.1	Do.
B25286	38-148B	do	*Atriplex canescens*	.1	Do.
B23511	26	500 feet north of W¼ corner sec. 2, T. 107 N., R. 78 W., Lyman County, S. Dak.	Boyd clay loam, 0-8 inches.	2.5	Composite of 5 samples from a 100-foot square.
B23545	26	do	Boyd clay loam, 8-15 inches.	3	
B23546	26	do	Boyd clay loam, 15-22 inches.	3.5	
B23547	26	do	Boyd clay loam, 22-30 inches.	6	
B23548	26	do	Boyd clay loam, 30-36 inches.	8	
B23549	26X	do	Selected concretions from 20 to 36-inch layer.	2.5	
B23550	26A	do	Ripe sunflower seeds	4	Vegetation growing on the 100-foot square; collected July 19, 1938.
B23551	26B	do	Sunflower leaves	2	
B23552	26C	do	Russian-thistle	3	At thorny stage.
B23553	26D	do	*Lygodesmia* sp	7	
B23554	26E	do	Young *Grindelia*	20	
B23555	26F	do	*Grindelia* sp. leaves (from plant just coming into bud).	20	
B23556	26G	do	*Solanum rostratum* Dunal.	3	
B23557	26H	do	*Panicum capillare* var. *occidentale* Rydb.	1	
B23558	26I	do	Western wheatgrass	2	
B23559	26J	do	*Setaria viridis* (L.) Beauv. (green bristle grass).	2	
B23560	26K	do	*Salvia lanceifolia* Poir	4	
B23561	26L	do	*Polygonum aviculare* L	1	
B23562	26M	do	*Amaranthus blitoides* Wats.	.5	
B23563	26N	do	*Malva parviflora* L	15	
B22990	R16	7½ miles south of Iona, Gregory County, S. Dak.	Pierre clay loam	7	
B22991	R16A	do	*Astragalus racemosus*, tops.	2,530	Collected May 27, 1938.
B22992	R16A	do	*Astragalus racemosus*, roots.	230	Do.
B22993	R17	2.7 miles south of Iona, Lyman County, S. Dak.	Raw shaly soil in ditch.	4	
B22994	R17A	do	*Astragalus racemosus*, blooms and leaves.	2,600	Do.
B23536	23A	do	*Astragalus racemosus*, leaves.	790	Collected July 16, 1938. Same plant as B22994.

TABLE 12.—*Selenium content of miscellaneous samples*—Continued

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B24703	371A	2.7 miles south of Iona, Lyman County, S. Dak.	*Astragalus racemosus* leaves.	630	Collected Aug. 20, 1938. Same plant as B22994.
B22995	R1S	6½ miles south of Pierre on Route 283, Stanley County, S. Dak.	Shaly soil in ditch	1	
B22996	R1SA	do	*Astragalus racemosus*	50	Collected May 28, 1938.
B22968	R1	Fullerton, Nance County, Nebr.	Yellow shale	.1	
B22969	R2	do	White shale	.1	
B22970	R3	do	Yellow fossiliferous shale.	.7	Northeast on Cedar Creek.
B22971	R4	do	Niobrara chalk	5	Under bridge.
B22972	R5	4½ miles southeast of Yankton on Highway 15, Cedar County, Nebr.	Ferruginous scum	6	Niobrara formation.
B22973	R5A	do	Young sunflower and a deep-rooted unidentified plant.	5	
B22974	R5B	do	Young growth of unidentified perennial.	12	
B22975	R6	SW¼ sec. 15, T. 32 N., R. 1 E., Cedar County, Nebr.	Boyd clay loam, 0–8 inches.	8	
B22976	R6A	do	*Astragalus* sp	15	
B22977	R7	NW¼ sec. 22, T. 32 N., R. 1 E., Cedar County, Nebr.	Boyd clay loam	1	
B22978	R7A	do	Young gumweed	4	
B22979	R7B	do	Young wheat	3	
B22980	R8	SE¼ corner, sec. 1, T. 31 N., R. 1 E., Cedar County, Nebr.	Very fine sandy loam, 0–12 inches.	3	
B22981	R8	do	Very fine sandy loam, with shale fragments 2–30 inches.	3	
B22982	R8A	do	Very young Russian-thistle.	7	
B22983	R9	SW¼ sec. 1, T. 31 N., R. 1 E., Cedar County, Nebr.	Yellowish clay, 2–3 feet.	5	
B23008	R25	42 miles south of Jordan on State Road 22, Garfield County, Mont.	Mottled yellow clay, 3–4 inches.	.5	Collected May 24, 1938.
B23009	R25A	do	*Astragalus bisulcatus*	520	Do.
B23010	R26	25 miles south of Jordan, Garfield County, Mont.	Yellow clay loam, 0–8 inches.	1.5	Do.
B23011	R26A	do	*Astragalus pectinatus*	770	Do.
B23378	7	12 miles south of Eads, on State Road 59, Kiowa County, Colo.	Yellowish brown clay loam, 0–12 inches.	1	
B23379	7A	do	*Astragalus racemosus* seeds and pods	320	Collected June 28, 1938.
B23380	7B	do	*Astragalus racemosus* tops and seeds.	70	Tough and woody. Collected June 28, 1938.
B23733	89	10.4 miles north of Chadron, Dawes County, Nebr.	Rotten gray shale, 24–32 inches	1	
B23734	89A	do	*Astragalus racemosus* leaflets.	10	Collected Aug. 4, 1938.
B23735	89B	do	*Astragalus racemosus* stems.	5	Do.
B23736	89C	do	*Astragalus racemosus* roots.	7	Do.
B23737	89D	do	*Astragalus racemosus* seeds.	8	Do.
B24127	172	2 miles south of Winnett on State Road 18, Petroleum County, Mont.	Brown clay loam, 0–8 inches.	1.0	
B24128	172A	do	*Astragalus bisulcatus* leaves.	25	Collected Aug. 14, 1938.
B24129	172B	do	*Astragalus bisulcatus* seeds.	30	Do.

TABLE 12.—*Selenium content of miscellaneous samples*—Continued

Laboratory No.	Field No.	Place of collection	Material	Selenium as Se	Remarks
				P. p. m.	
B24343	241A	5 miles south of Conrad on U. S. Route 91, Pondera County, Mont.	*Astragalus bisulcatus* seeds.	1,210	Collected Aug. 19, 1938.
B24344	241B	do	*Astragalus pectinatus* seeds.	3,360	Do.
B23345	18	W¼ corner sec. 33, T. 14 S., R. 35 W., Logan County, Kans.	Niobrara clay loam, 0–3 inches.	1.5	
B23346	18	do	Niobrara clay loam, 3–10 inches.	.7	
B23347	18	do	Niobrara clay loam, 10–24 inches.	1	
B23348	18	do	Niobrara clay loam, 24–36 inches.	1.5	
B23349	18	do	Niobrara clay loam, 36–48 inches.	2.5	
B23350	18	do	Niobrara clay loam, 48–60 inches.	1.5	
B23351	18	do	Niobrara clay loam, 60–72 inches.	2.0	
B23352	18A	do	*Astragalus pectinatus*	150	Collected July 2, 1938.
B23401	18B	do	*Astragalus pectinatus* seeds and pods.	3,300	Do.
B23402	19	W¼ corner sec. 14, T. 13 S., R. 35 W., Logan County, Kans.	Niobrara loam, 0–8 inches.	3.5	
B23403	19A	do	*Stanleya* whole plant.	290	Do.
B23404	19B	do	*Stanleya* leaves	25	Do.
B23405	19C	do	*Stanleya* seeds	1,120	Do.
B23591	127A	25 miles northwest of Belle Fourche, Crook County, Wyo.	Ripe *Stanleya* seeds	1,960	Collected Aug. 7 1938.

On a farm in Lyman County, S. Dak., set aside for studies of alkali disease in grazing animals by the Farm Security Administration, there was selected a location from which a variety of vegetation could be secured. A square, 100 feet on the side, was marked off, and a composite sample of soil for each depth was prepared from five samples taken on four sides and in the center of the square. The soil samples B23544–B23549 (table 12), increased from 2.5 p. p. m. of selenium in the surface 8 inches to 8 p. p. m. at the 30- to 36-inch depth. All the different kinds of vegetation growing on the plot were sampled. The selenium content of the 14 samples of vegetation thus secured, B23550–B23563, varied from 0.5 to 20 p. p. m. No absorber plants were present. It will be noted that although this farm is known for its selenium trouble and the fact that the soil is fairly high in selenium, one-half of the vegetation samples contained only 3 p. p. m. or less of selenium. The dominant vegetation was sunflowers, the grasses forming but a small percentage of the cover (fig. 7).

Although a great variety of native vegetation was collected in Gregory, Lyman, and Stanley Counties, S. Dak., in 1934 (4), *Astragalus racemosus* was not found. This plant was observed in three locations along the road in the spring of 1938 and collected (table 12). The selenium content ranged from 50 p. p. m. (B22996) in Stanley County to 2,600 p. p. m. (B22994) in Lyman County. Samples B22994, B23536, and B24703 were taken at intervals during 1938 from the same *A. racemosus* plant in Lyman County (table 12 and fig. 7). The first sample was collected May 27 and contained 2,600 p. p. m.; the second was collected July 16 and contained 790 p. p. m.; and the

last was collected August 29 and contained 630 p. p. m. Figure 8 shows the plant after the final collection. The first sample collected from the plant was a mixture of blooms and leaves, while the other two samples were leaves. The first and the last two samples cannot be used for making a seasonal comparison of the selenium content of a given portion of the plant. However, the samples represent the outer edge of the plant, the portion that would be nipped off and eaten by a grazing animal, and from this standpoint they give a seasonal comparison of the toxicity of the plant. It is easily seen that the plant was decidedly more toxic in bloom season than later in the growing season.

A small exposure of the Niobrara formation at Fullerton, Nance County, Nebr., was reported to one of the authors by George E. Condra, of the University of Nebraska. Four samples of shale and

FIGURE 7.—The vegetative cover of the 100-foot square from which all plant species were examined for selenium.

chalk, B22968–B22971 (table 12) were collected at this point. The sample of chalk contained 5 p. p. m. of selenium. On a similar spot in Cedar County, Nebr., B22972–B22974, a ferruginous seam in the formation contained 6 p. p. m. of selenium, and two samples of native vegetation had 5 and 12 p. p. m. of selenium, respectively. Nine samples of soil and vegetation, B22975–B22983, in the same area as B22972 show the presence of adequate selenium to list the area as seleniferous. These data are further evidence that small areas of seleniferous soils, capable of producing vegetation injurious to stock, exist in soil regions predominately of loessial or glacial origin.

Two soils derived from the Fort Union formation were collected in Garfield County, Mont. These soils, B23008 and B23010, contained 0.5 and 1.5 p. p. m., respectively, and produced toxic *Astragalus*, B23009 and B23011. These samples furnish further confirmation of the existence of seleniferous areas of soils derived from post-Cretaceous formations (*3*, *5*, *34*).

The selenium content of eight samples of seeds, two each of *Astragalus racemosus*, *A. bisulcatus*, *A. pectinatus*, and *Stanleya* sp., is given in table 12 (p. 63), together with all available data on plants from which the seeds were taken and the soils on which they grew. The

minimum amount of selenium found in these seeds was 8 p. p. m. in a sample of *A. racemosus* (B23737), and the maximum was 3,360 p. p. m. in a sample of *A. pectinatus* (B24344). The data indicate a concentration of selenium in the seeds of these plants.

In a sample of 100 gm. of human teeth secured from a dentist in Washington, D. C., 0.005 mg. of selenium was found. The reagents were free of detectable amounts of selenium. Hance (*20*) has reported a sample of teeth, which he analyzed, to be free of selenium.

SUMMARY

A review of recent literature on topics related to the selenium problem is given.

The selenium content of about 1,000 samples of wheat and wheat products from seleniferous areas was determined, and the results tabulated alphabetically by States and by counties within a State. Samples of wheat and wheat products containing sufficient selenium to be toxic to domestic animals were found. The maximum selenium content found in wheat was 25 p. p. m. From the known facts the authors believe selenium to be present in all wheat in detectable amounts. Insofar as human food is concerned, the mingling in elevators and mills of relatively insignificant amounts of high selenium wheat with great quantities of wheat having only traces of selenium is doubtless a protective factor. Because there is little in the literature that permits an appraisal of the selenium intake tolerated by human beings, without injury, all references to toxicity in this bulletin relate to experimental or domestic animals.

FIGURE 8.—*Astragalus racemosus* plant after the third sampling.

Nearly 300 samples of barley, corn, oats, and rye were collected in seleniferous areas. The analysis of these samples is given. The maximum selenium content found in these grains was 30 p. p. m. in a sample of corn.

The selenium content of samples of many other kinds of crops is also given.

The selenium content of samples collected on a reconnaissance survey in Alberta, Saskatchewan, and Manitoba Provinces of Canada is given. Large areas were found that produce toxic vegetation. Animals in these areas apparently suffering from chronic selenium poisoning were observed.

North Dakota and Idaho were added to the list of States in which seleniferous soils have been found.

Five soil profiles and the *Astragalus* growing in them were collected in Montana. An *A. pectinatus* containing 2,140 p. p. m. of selenium was found in a profile that contained 0.2 p. p. m. at 30 to 50 inches to 0.5 p. p. m. in the surface 0 to 6 inches.

All the samples of normal urine examined were found to contain selenium.

Of the 22 samples of meteorites examined 15 were found to contain selenium in amounts ranging from 0.5 to 235 p. p. m.

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